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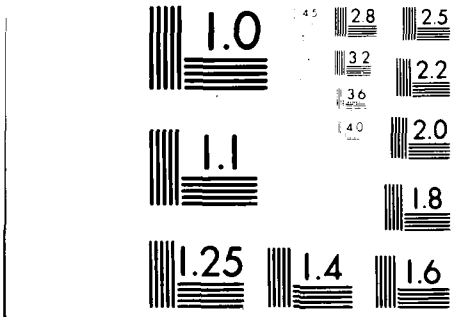

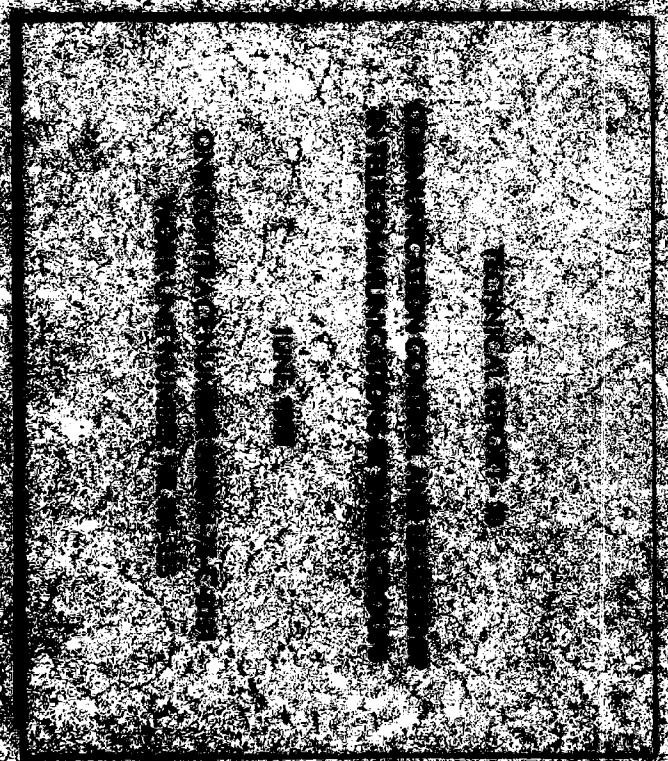

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This experiment examined the effect of communication control on the telecommunications of four-subject problem solving groups, and on the emergence of leaders within the groups.

Sixteen four-subject teams solved four realistic problems, one on each of four days, by communicating over a closed-circuit television system with an added audio capacity. Teams were assigned to communication systems which either did or did not have centrally controlled switching so that only one person

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could talk at a time, and to systems in which either (1) one subject was appointed to perform some of the experimenter's tasks or (2) no group member was so designated. Four degrees of control over communication thus ranged from no control (communication was not centrally switched, no appointed helper) to absolute control (appointed helper who switched the communication). The subject who switched the communication and/or helped the experimenter was chosen at random by the experimenter prior to the start of the first experimental session and remained the same throughout the remaining sessions.

Teams were paid a bonus of up to $2.60 for each problem solution. The size of a team's bonus depended on how well the team solved each problem as determined by comparing their solutions with criterion solutions. Dependent measures include the time to solution, a measure of the quality of solution based on the size of the bonus, measures of verbal communication, and questionnaire responses.

Teams in the switched condition took longer to solve problems than did teams in the non-switched condition (27.2 vs 19.1 minutes). The variability of these times was significantly greater in the switched condition than in the non-switched condition, largely due to several extreme data points. Although the same number of words was used in both conditions, subjects in the two conditions "packaged" their messages differently. Subjects in the switched condition used fewer but longer messages than did subjects in the non-switched conditions.

Analysis of the quality of the team's solutions indicates that none of the independent variables of primary interest made a difference in how well teams solved problems.

Several changes throughout the four sessions indicate that subjects learned or adapted to the experimental situation. The number of words and messages decreased and, in the switched condition, the number of words per message increased.

The questionnaire responses reveal that while the two main independent variables in this study -- switching and helping responsibilities -- were mentioned as reasons why some subjects emerged as leaders, they were not the most frequently mentioned reasons. These results, together with the more objective performance data, suggest that mechanical variables such as those manipulated here are less important than other variables in the emergence of leadership.

The questionnaire responses also show that subjects generally liked communicating with the telecommunication system and that the switched and non-switched systems were liked about equally well.

Communication Control and Leadership in Telecommunications by Small Groups

Peter D. Pagerey

Based on a dissertation submitted to The Johns Hopkins University in conformity with the requirements for the degree of Doctor of Philosophy.

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Department of Psychology

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TABLE OF CONTENTS

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ABSTRACT

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INTRODUCTION

Recent advances in electronic, computer, and satellite technology have greatly expanded the ways in which people can communicate interactively through electronic systems. Some telecommunication systems use devices, such as the telephone or television, that are familiar to us because they have been around for a relatively long time. Others use less commonplace devices, such as the telewriter and slow scan television, that have been developed more recently. Examples of telecommunication systems include voice conferencing systems such as the British Post Office LST4 (Willians, 1975), audio-video conferencing systems such as the AT&T Picturephone (Falk, 1973), and the British Confravision System (Williams, 1973), telewriter systems such as the Rand Tablet (Chapanis & Williams, 1976), and various computer mediated teletype systems (Vallee, Johansen, & Spangler, 1975; "The future of." 1975).

Unfortunately, the design of some of these new systems has encountered problems. One problem concerns the best way to design an audio-video multi-site teleconferencing system. Specifically, the question is how to configure a communication network when more than two sites are to be linked. Cost is a major factor because the amount of transmission, reception, and display equipment required at each site may vary greatly depending on the configuration. For example, to conduct an audio-video conference between two sites requires transmission and reception equipment, at least one camera, monitor, microphone, and speaker, at each locale. When the communication system is designed to be continuously open, each participant can be continuously seen and heard by the other. Although communicating over a continuously open system is much like communicating face-to-face, the cost of such a system is high. Adding additional sites to the conference increases disproportionately the new amount of equipment required, since each new locale must possess sufficient transmission and reception equipment, cameras, microphones, monitors, and speakers, to receive communications from all the other sites.

A number of approaches have been tried to reduce

costs. One is to consider video a luxury and not use it. Another alternative is to use some sort of switching mechanism, for example, voice switching, so that only one conferee, usually the one talking, is viewed at a time. In voice switching, each speaker has his own microphone but shares a camera with other conferees. The camera is mounted on an electro-mechanical drive and the output signals of the camera activate the camera's servomechanism so that the camera rotates and is trained on the speaker while he speaks. When another conferee speaks the camera rotates to capture the new speaker. Examples of systems using the voice switching are the Bell Laboratories' private video conferencing system operating between Murray Hill and Holmdel, New Jersey (Brown, Limb, & Prasada, 1978; Hoecker, Brown, Wish, & Geller, 1978), AT&T's Picturephone® Meeting Service, and Westinghouse's Communication Satellite Test facility link operating between Baltimore, Maryland, and Lima, Ohio (Bretz, 1974).

Up to now, voice switching has been used when more than one speaker or group of speakers is located at one of two sites. The technique has not been made workable for multisite conferences. Even if it could be made workable, users tend to complain about the "jerkiness" of the video signal when exchanges among conferees take place rapidly.

Another method of switching is to have the video signals controlled by a central operator, as is now done in the teleconferencing system in use in the Omaha Veterans Hospital (Johansen, Vallee, & Spangler, 1979). In this system, switching is at the discretion of an operator who determines who or what is to be viewed. This system clearly requires close coordination between conferees and operators.

Still another kind of switching mechanism is that used by the New York Metropolitan Regional Council (MRC)(Bretz, 1974). The MRC system links nine remote studios to a central studio at the World Trade Center in New York City. The audio signal is continuously open and allows conferees to interrupt freely. The video is not continuously open. It is controlled by a system that operates roughly according to the formal

methods of gaining the floor embodied in Roberts Rules of Order. Each of the nine studios has a "request-to-talk" button that participants at the remote locations push whenever they want to be seen while talking. An operator at the central site responds to requests by activating the camera at the appropriate site. A split screen permits two sites to be seen at the same time.

Purpose

The purpose of this experiment was to compare two methods of dealing with the multi-site teleconferencing problem. One method was to leave the audio and video channels continuously open. The second was similar to the MRC system in which the audio was not continuously open. Rather, subjects had to "request to talk" whenever they wanted to be seen and heard.

The specific purposes of this experiment were to examine the effect that communication control in the form of the "request to talk" feature has on the telecommunications of four-man problem solving groups, and on the emergence of leadership in those groups.

LITERATURE REVIEW

Three areas of research are relevant to this study: (1) research on telecommunication, (2) social psychological research on communication networks, and (3) social psychological research on the emergence of leaders in small groups.

Telecommunications Research

Pertinent telecommunications research has been done in the Wired City Laboratory at Carleton University and the Telecommunication Research Laboratory at The Johns Hopkins University.

Carleton University

Only one study from the Wired City Laboratory is of interest. Unfortunately, the results have not appeared in the open literature and only preliminary findings are available.

The study examined the emergence of leadership in the context of a typical human relations problem. Two modes of communication were used: video and face-to-face. What results were presented indicate that "people seem to be more stable and differentiated in their idea quantity, idea quality, and likeability in the face-to-face conditions" (Coll, George, Strickland, Paterson, Guild, & McEown, 1975, p. 68).

The Johns Hopkins University

One research study from the Hopkins Group is particularly germane to this experiment. Chapanis and Overbey (1974) conducted an experiment on dyadic communication in which members of two-man teams used either similar or dissimilar communication channels. In the similar communication channel condition, both subjects used either a voice link or a teletypewriter link to

communicate. In the dissimilar condition, one subject communicated by voice and the other by teletypewriter.

Teams in both of these conditions had either one of two interchange options. In the free interchange condition, a subject could freely interrupt his partner at any time and could also release his channel to his partner at any time. In the restricted interchange condition, a subject could only turn his channel off. He could not interrupt his partner nor could he gain control until his partner relinquished the channel.

The results of the study indicate the importance of the freedom to interrupt and the freedom to gain the channel. Although the interchange variable did not affect the time subjects took to solve problems, the number of words they used, or their rate of communication, it did affect the way subjects packaged their words. To quote the authors:

> ... communicators "package their words differently according to whether they can, or cannot, interrupt. When communicators have the freedom to interrupt, they exchange more messages, messages are shorter, and messages are exchanged faster. These mean effects are accompanied by changes in variance. That is, not only are more messages exchanged and exchanged faster under conditions of free interchange, but the variability of these two dependent measures increases among the several modes and, in the case of messages per minute, for job roles as well. Similarly, under conditions of free interchange, messages are not only shorter on the average, but the variance of message lengths is much smaller for the various combinations of modes and job roles. (Chapanis & Overbey, 1974, p. 373)

The Communication Network Studies

Research on communication networks began with the

work of Leavitt (1951) and has been an area of considerable activity since that time. Summaries have been prepared by Shaw (1964) and by Snadowsky (1974).

Communication networks are patterns of channels of communication between members of an organization or a group created by the assignment of responsibilities and the delegation of duties. In early experiments, groups sat around a table which had been divided by partitions. Group members communicated with one another by passing handwritten notes through slots in the partitions which were opened or closed by the experimenter, depending upon the communication pattern being studied. The patterns studied are similar to patterns that might be found in actual groups or organizations. For example, in the wheel pattern the communication network resembled a wheel. One group member occupied a central position with the other members seated around him. The members at the periphery of the wheel had to send messages through the central position. The member occupying the central position routed the messages to their proper destination and therefore controlled who communicated with whom.

Another example of a communication network is the "comcon" pattern. In this network, the slots in the partitions were all opened, so that subjects were able to communicate with one another freely and directly. Problems involved symbol-, letter-, number-, and color-identification tasks. Somewhat more complex problems have typically involved arithmetic computation, work arrangement, and sentence construction, and a number of studies have used discussion problems similar to the problems used in this experiment (see section on Problems).

Dependent measures have generally included the time it takes groups to solve the problems, the number of messages sent, the number of errors made, and the satisfaction of subjects with their participation in the task.

Shaw's (1964) summary of 18 experiments performed up to that time showed that in every experiment teams in decentralized communication networks, e.g., comcon,

solved complex problems faster than teams in centralized networks, e.g., wheel. At the same time, in 17 of the 18 experiments teams in the decentralized networks sent more messages than did those in centralized networks. Out of 11 experiments that examined satisfaction, 10 showed that participants in the decentralized networks were more satisfied with their participation than were those in the centralized networks. The data on errors are not so clearcut. In six out of ten experiments teams in centralized networks made more errors than did those in decentralized networks. Subjects in central positions in centralized networks were generally more satisfied with their performance and were more likely to emerge as leaders than were subjects occupying the peripheral positions. All these findings hold for simple problems except for the time it took to solve problems. In 14 of the 18 experiments, teams in centralized networks solved simple problems faster than teams in decentralized networks.

Leavitt's (1951) explanation for these differences is based on the notions of saturation and independence. Saturation refers to an overload of communication input, output, and task requirements on a net position. If saturation occurs in a net position, the result is a slower time to solution. Since saturation is most likely to occur in centralized networks at the central position during the solution of complex problems, this concept explains why the solution of complex problems takes longer in centralized networks than in decentralized ones.

Independence refers to the freedom of action of a network position and is directly related to satisfaction. In a centralized network, the central position has more freedom of action than the peripheral positions with the result that subjects in the former position are more satisfied than are those in peripheral positions. In decentralized networks, each position has equal freedom of action with the result that subjects in all positions are equally satisfied.

Emergence of Leadership

A considerable amount of research has been done on the topic of leadership. In his Handbook of Leadership, Stogdill (1974) compiled a 150-page bibliography listing over 3,000 books and journal articles related to this subject!

From this large body of research investigators have not succeeded in arriving at a single definition of leadership. The most commonly accepted one views a leader as someone who influences, controls, and directs others. For example, Pigors defines leadership by stating that a leader's "will, feeling, and insight direct and control others in the pursuit of a common cause" (Pigors, 1935, p. 12). Seeman and Morris extend this definition as follows: "Leadership acts are acts by persons which influence other persons in a shared direction. This definition implies a positional relationship between the 'leader' and other persons. A leader position is defined in terms of relative status in an influence hierarchy" (Seeman & Morris, 1950, p. 1). For the purposes of this research leadership is defined in terms of both influence and positional relationship.

One area of research on leadership that has received a lot of attention deals with the emergence of leadership in initially leaderless groups. Groups that are initially leaderless will, by the end of a task or problem solving session, probably have a leader. This phenomenon of emergent leadership has been clearly documented by a large number of researchers. The individual who comes to be leader in this situation is not formally or overtly elected or chosen by the other group members. Rather, his leadership and influence are accepted on an unspoken level. An individual may come to be considered his group's leader by exhibiting a number of characteristics: Emergent leaders talk more than other group member (Bales, 1953; Bass, 1949, 1954; Jaffee & Lucas, 1969), have higher task ability (Carter & Nixon, 1949; Hollander, 1964), are more dominant (Rohde, 1951), possess information needed to solve the problem (Hemphill, Pepinsky, Shevitz, Jaynes, & Christner, 1956), and present the best ideas (Bales, 1953). Because the problem solving groups in this experiment were initially

leaderless, these same characteristics were included in a questionnaire question about the emergence of leadership (see Method section, Questionnaire subsection).

HYPOTHESES

Three main hypotheses were generated from the results found in the literature:

1. Subjects who communicate through a highly centralized communication network to solve problems should be less satisfied with their participation than subjects who communicate through a decentralized network. In this study a centralized communication network is operationalized by means of a switching system similar to the MRC network. A decentralized network is provided by continuously open audio and video channels (see Method section, Switching subsection).

2. Subjects who communicate through the centralized, switched communication network should take longer to solve problems and should use fewer messages than subjects who communicate through a nonswitched system.

3. Subjects who are given special powers and responsibilities are more likely to become leaders of their groups than are subjects who are given no special powers.

METHOD

Subjects

Sixty-four Johns Hopkins University male undergraduates participated as subjects in this experiment. In addition, eight undergraduates participated as the subjects of two teams whose data were excluded from data analysis because of problems that occurred during the experimental sessions. Twelve graduate students served as subjects in six pilot sessions.

Subject recruitment is discussed in the Procedure section.

Modes of Communication

Subjects in this experiment communicated through audio and video channels in a kind of closed-circuit television communication system. These channels were chosen because research has shown that the video channel facilitates the emergence of a leader in initially leaderless groups.

Facilities

The laboratory facilities occupy a block of four rooms similar in size (10' x 10'), decor, and communication apparatus available for use.

One pair of adjacent rooms is separated from another pair of adjacent rooms by a central observation/equipment storage room. Windows silvered on one side permit observers in the central observation room to watch subjects during experimental sessions without being seen by the subjects.

The four rooms were designated A, B, C, and D. During the experiment, the subject assigned to a room was identified by the same letter (see Procedure section).

Audio and Video Communication Equipment

The communication equipment in each room consisted of a microphone, a camera, three speakers, and three television monitors. The subject sat at one end of a 6' x 3' table facing the three monitors, the three speakers, and the camera. The three monitors were arranged side by side. The two outer monitors were Setchel Carlson 19" black and white monitors (model 9M-902). The third was a Sony 19" Monochrome television (model CVN-194) modified for use with the audio and video communication systems. Each monitor, and the speaker paired with it, received the communication signal of only one other team member. The team member who could be viewed or heard on a monitor was identified by a card with his identification letter on the monitor. A Sony Electrical Condenser Microphone (model ECM-200) mounted on a small, weighted stand was on the table directly in front of the subject. Subjects were free to move and to orient the microphone as they wished.

Audio signals from each room were sent to the speakers in the other three rooms. The Sony television had an internal speaker. Since the Setchel Carlson monitors did not have internal speakers, Lafayette 8-ohm speakers (model 99-4550) placed adjacent to the appropriate monitors carried the voices of the subjects who appeared on them. To make transcription of the audio tape recordings of the communications easier, the output of each microphone was also recorded on a separate track of a Teac 4-channel SIMULSYNC Stereo tape recorder (model A-2340SX).

A video camera was mounted on each of the center monitors. A Sony Video camera (model CVC-2100A) with a Cosmicar Television lens was placed in subject A's room. Sanyo Viewfinder cameras (model VCM 2000) with Sony lenses were located in B's and C's rooms. Finally, a Sony Video camera (model AVC-3200) with a Sony lens and Tamron lens adapter combination was located in D's room.

The cameras and lenses were matched to give approximately equal width of the field of view. The cameras were tilted downward so as to capture the head and

upper body of the subject and about one foot of his table.

Signalling and Switching System

In the "no switching" condition, subjects were free to talk whenever they wished. Since both the audio and video channels were continuously open, subjects were free to interrupt or talk when another team member was talking.

In the "switching" condition, only one person could be heard and seen at a time. One of the four subjects controlled who spoke and when they spoke. The other three had to signal the fourth whenever they wanted to speak.

The subject who had been randomly assigned to room B had the master switching control box in his room and performed the function of communication controller or switcher. Across the top of his box was a row of three red indicator lights corresponding to the other three subjects. Whenever a subject made a request to talk, his light came on with the message, "A (or C or D) WANTS TO TALK." Subject B, of course, had no such light because he controlled the system. Across the bottom of the master control box was a row of four green transilluminated pushbutton switches, one corresponding to each of the four team members. When they were lit, they said, "A (or C or D) IS NOW TALKING," or in the case of B's own light, "YOU MAY NOW TALK."

Subjects A, C, and D had a signal box with a red light and pushbutton and a green status light. When they were lit, the red light said, "I WANT TO TALK," and the green light, "YOU MAY NOW TALK."

Whenever a subject wanted to talk he pressed his pushbutton which simultaneously lit the "I WANT TO TALK" light on his own panel, and the "A (or C or D) WANTS TO TALK" on B's panel. Whenever B pushed one of his pushbuttons, his action cancelled the red "I WANT TO TALK" light and lit the green "YOU MAY NOW TALK" and "A (or C or D) IS NOW TALKING" lights.

Switching Action Recording Apparatus

An Esterline-Angus electromagnetically operated, 20 pen recorder recorded the sequence, the time of occurrence relative to the start of the session, and the length of activation of all button pushes.

Appointed Helper

The second independent variable of interest is the appointed helper variable. Unlike the switching variable which is a system-based manipulation, the appointed helper variable is a social psychological manipulation, and as such is independent of the communication system.

In conditions having an appointed helper, the subject assigned to room B performed some of the experimenter's duties. The general instructions (see the Procedure section) clearly enumerated the duties of the helper. All four team members therefore knew (a) who the helper was, (b) that he was special by virtue of being chosen by the experimenter, (c) why he was chosen, and (d) what he would do. The helper was also given a card on which his duties were listed.

Because of his special powers and responsibilities, the helper was expected to become the team's leader. The power the helper possessed derives in part from what French and Raven (1962) call legitimacy because it was the experimenter, a legitimate authority figure in the experimental situation, who legitimatized the helper as a leader by picking him. The duties and responsibilities a helper performed were meant to strengthen his position as group leader, i.e., to create a status or influence hierarchy where none previously existed.

The helper also possessed, by virtue of having the only set of instructions, what Deutsch and Gerard (1955) called information power. In the previous experiments in this series and in the conditions of this experiment which had no appointed helper, the experimenter read the instructions to the subjects. Each subject also received a complete set of instructions containing problem-solving information for reference during the

session. In this experiment, by contrast, the helper was the only one who received a set of instructions. The group therefore became dependent upon the helper for problem-related information. For three of the problems, his teammates received partial information containing only the topics that were to be discussed during the problem-solving session (see the section on Problems). For the brainstorming problem, they received no information at all.

The helper also acted as the group spokesman or liaison agent with the experimenter. If one of the group members had a question or problem that he normally would have addressed to the experimenter, in this condition he did so by way of the helper. The helper, again in his liaison capacity, also told the experimenter when consensus about a problem solution had been reached and what the consensus solution was. Before the team was dismissed from the session, it was his responsibility to arrange a time with the other group members when the next experimental session would be held.

It was important to provide a rationale for why the helper had been given a number of responsibilities that distinguished him from his fellow teammates. Many of the responsibilities were ones that would have to be taken care of by the experimenter, e.g., reading instructions, arranging session times. In fact, the duties were performed by the experimenter in the no appointed helper condition. It seemed reasonable, therefore, that the helper should come to see himself as helping the experimenter by performing some of the duties normally performed by the experimenter. The rationale given to the subjects was that the helper was performing some of the experimenter's duties in order to help the experimenter in a rather complex situation. The general instructions stated that the reason there was a helper was so that the helper could "make this (the experiment) go a little smoother for all of us."

Problems

The four problems used in this experiment were a

Fire Safety and Prevention problem, an Energy Conservation problem, a National Issues Ranking problem, and a University Budget problem.

Several criteria were used in selecting problems for this experiment. Each problem had to be formulated in such a way that it would engender group discussion and a consensus solution. The communication created by the problem solving effort had to be largely discussion though some persuasion and argumentation was acceptable. The problems had to have solutions that could be evaluated according to some kind of criterion. Finally, the topics had to be familiar and to require no special information to solve.

Fire Safety and Prevention Problem

The Fire Safety problem had not been used before in the Hopkins Telecommunications Research program. In the instructions (Appendix A), subjects were told to imagine themselves as "student member(s) of a committee which [had] as its goal the increased awareness of fire safety and prevention among students." Specifically, their task was to "prepare a list of the 15 best actions that should be taken by students to prevent fires where they live."

The bonus for this problem was based on the number of items from the consensus list that matched items on a list compiled by the National Fire Prevention Association (NFPA). The criteria taken from the NFPA list are shown in Appendix B. I was rather liberal in deciding what constituted a match. I felt that as long as an item captured the essence of a criterion item, though not its exact wording, a match was made. The size of the bonus was calculated by multiplying the number of matches by $.173. Multiplying by $.173 gave a range from $0.00 for no matches to $2.60 for 15 matches. The maximum and minimum bonuses were the same for each problem.

Energy Conservation Problem

The Energy Conservation problem was similar to one

which had been used previously, although specific details of the problem were changed so that the solution was different. Subjects were told to imagine that they had recently purchased "an old two-story brick row home." The house was described as having 1,350 square feet of floor space with 13 windows and two doors. The row home was in dire need of maintenance and had no insulation. Further information is given in Appendix C.

The task was to pick the four best home improvements from a list of eight suggested by the experts. The eight home improvements are listed in Table 1. "Best" was defined in terms of cost-effectiveness, i.e., the ratio of net savings to installation costs. The four best have the highest savings to cost ratios. The home described earlier actually exists. Calculations based upon a United States Department of Housing and Urban Development (1975) publication were made for the home so that the savings to cost ratio for each improvement was known.

The bonuses were determined by using a specially constructed table (Table 2) to make the assignments of bonuses easy. The table was constructed by first rank-ordering the eight improvements in terms of their savings to cost ratios and then assigning the highest ratio the value of eight, the second the value of seven, the third six, and the fourth five. The rest, the lowest four ratios, were given a value of zero because they would not count as being among the four best. Next, all the different combinations of four of the eight numbers 0, 0, 0, 0, 5, 6, 7, and 8 were determined. The combinations (there were 16) were summed and the sums were then rank ordered. The maximum bonus of $2.60 was divided by the number of permutations to give $.173. Each step up the rank ordering of sums, starting at 0000 which was given a value of $0.00, was increased by $.173. With rounding this gives a range from $0.00 to $2.60.

National Issues Ranking Problem

The National Issues problem was one of the two rank-ordering problems used in this experiment. Both had been used in a previous experiment (Weeks & Chapanis, 1976). A copy of the problem materials is given in Appendix D.

TABLE 1

The Eight Home Improvements Used in the the Energy Conservation Problem and the Savings to Cost Ratio for Each

	Home Improvements	Savings to Cost Ratio
1.	Have the central air conditioning checked annually by a professional	.045
2.	Insulate the basement walls	.330
3.	Have the oil furnace checked annually by a professional	.600
4.	Insulate the frame walls	.840
5.	Caulk and putty around the windows and door frames	1.000
6.	Put on glass storm windows	1.880
7.	Insulate the attic	11.780
8.	Weatherstrip the windows and doors	20.980

TABLE 2

Bonuses for Energy Conservation Problem

Permutation	Sum	Bonus ($)
0000	0	.00
0005	5	.17
0060	6	.35
0700	7	.52
8000	8	.69
0065	11	.87
0705	12	1.04
8005	13	1.21
0760	13	1.39
8060	14	1.56
8700	15	1.73
0765	18	1.91
8065	19	2.08
8705	20	2.25
8760	21	2.43
8765	20	2.60

In the introduction to the problem, subjects were told that "many unresolved issues face this country." A list of the issues that the subjects discussed is given in Table 3. Subjects were then told to imagine that they had "been selected by [their] fellow students to represent them on an ad hoc committee." The purpose of the committee was to make recommendations to the President concerning the reordering of national priorities.

Both rank-ordering problems were done in two parts. In the first part subjects individually rank-ordered the ten items on the list. The ranking was done without discussion among the team members. Subjects were told to do the ranking as each thought the "average undergraduate would rank them [the issues] if he could reorder our national priorities in the order of their importance." The individual rankings were collected by the experimenter and were not shown to the other team members.

When all had finished the individual rankings, the experimenter (in the no-appointed-helper conditions) or subject B (in the appointed-helper conditions) told them that they were going to do a second ranking of the items. The second ranking required the team members to do the ranking as a group and to arrive at a single consensus ranking.

Subjects were also told that a questionnaire had previously been administered and that from the results of the survey the experimenter knew "how the average undergraduate would rank the ten items." The bonus they would be paid depended upon how close the consensus ranking was to the survey ranking.

The size of the bonus was calculated by first determining the rank correlation, ρ , between the average survey rank ordering and the consensus rank ordering (Mosteller & Rourke, 1973). The value of the rank correlation was then inserted into the following formula:

$$\text{bonus} = (\rho + 1) \times \$1.30$$

TABLE 3

Items Discussed in the

National Issues Ranking Problem

A. Provision of equal opportunity in education.

B. Achievement of a stable peace in the Middle East.

C. Control of inflation.

D. Finding a truly effective treatment for drug addiction.

E. Development of alternative energy sources (e.g., nuclear, solar).

F. Allocation of highway funds to mass transit.

G. Restoration of confidence in the political system.

H. Reform of the judicial and penal systems.

I. Achievement of zero population growth.

J. Increased consumer protection through legislation.

University Budget Problem

The University Budget problem dealt with a topic of great interest to students, "the rising costs of getting an education." The rising costs were manifested in the form of "increased tuition, lab fees, and room and board." Subjects were further told that while "cost increases seem to be an inevitable part of academic life, ...steps can be taken to reduce their size." The steps are shown in Table 4. Complete problem materials are shown in Appendix E.

As with the National Issues ranking problem, this problem had two parts. In the first, subjects ranked the ten items individually in the order they each thought "the average undergraduate would recommend them to the university." In the second part, subjects did the rankings as a group.

The size of the bonus depended on how close the group ranking was to an average survey ranking obtained in a previous experiment. The calculation of the bonus for this problem is the same as calculation for the National Issues problem.

Procedure

Subjects were recruited through recruitment posters placed on bulletin boards throughout campus. Interested students were directed to sign on a sign-up sheet their names, telephone numbers or mailbox numbers, and the times when they were most likely to be reached by telephone.

Students were telephoned in randomized order to break up groups of friends who had signed up together. No attempt was made to prevent friends from being on the same team. Students who had solved the two issue rankings in earlier experiments were excluded from the experiment.

Before teammates arrived for the first session, they were randomly assigned to laboratory rooms. When the four subjects arrived the experimenter took them

TABLE 4

Items Discussed in the University Budget Problem

A.	Delay construction of new buildings and renovation of old ones.
B.	Cut the plant operating expenses.
C.	Cut the M.S.E. Library operating budget.
D.	Freeze pay hikes for faculty.
E.	Freeze the hiring of new instructor personnel.
F.	Cut the size of the administrative staff and services.
G.	Raise the student tuition and fees.
H.	Decrease financial aid to students.
I.	Institute a tri-semester at the University.
J.	Eliminate the Intersession.

to their assigned rooms and asked them to be seated. The experimenter then read the general instructions.

A copy of the general instructions is presented in Appendix F. The instructions are in segments. Some segments, such as the general introduction on page one, the informed consent, and the description of the method of payment on pages 2 and 3, were read to all subjects. Other segments, such as the appointed-helper segment on page 1 and the switched segment on page 2, were read to subjects in the appropriate conditions.

After the general introduction and the condition-specific segments were read, the informed consent segment was read and the informed consent form was completed. Next, the section on payment was read and the payment form and the payment envelope were filled out.

Subjects were free to ask questions at any time. Ample time was given to answer every question unless the question was about the specifics of a problem solution or about the bonus. If such a question was asked, the experimenter told the subject who asked the question that the details of the problem would be fully explained after the experiment was completed. I told them that I did not disclose this information because I wanted everyone who participated to have a fair chance to receive the bonus money and that I did not want cheating. The experimenter took great pains to make sure that no subject felt that he was deceived by any aspect of the experiment or the experimental procedure.

At this point, the procedure for subjects in the appointed-helper condition differs from that for subjects in the no-appointed-helper condition. The difference in procedure is related to the difference between the two conditions (see Appointed Helper section). In the no-appointed-helper condition, a copy of the instructions was given to each of the subjects. The experimenter read the instructions and waited for questions. When the questions were answered, the experimenter started the tape recorder. The subjects were told to begin and simultaneously the timer was started. The switching action recorder was also started in switched conditions.

In the appointed-helper condition, the experimenter shut the doors to rooms A, C, and D. This permitted only subject B to interact directly with the experimenter. B was given the instructions so he could familiarize himself with them. When B was ready, the experimenter told him to begin reading the instructions to his teammates. The session began after B finished reading and all questions were answered. When the session was finished, the experimenter collected the solution from B. B received a calendar and a list of other scheduled sessions and made arrangements for the next session.

Dependent Measures

Six kinds of measures were collected in this study: (1) time to solution, (2) quality of solution, (3) verbal communication measures, (4) switching actions, (5) rankings from the rank ordering problems, and (6) questionnaire responses.

Time to Solution

The time to solution was the time that elapsed from when the experimenter told a team to begin until one of the subjects told him the team was finished. In teams with an appointed helper. the helper told the experimenter when the team was finished.

Quality of Solution

The quality of solution was equated to the size of the bonus each team received for its solution.

Verbal Communication Measures

Transcriptions were made of the audio tape recordings. Each transcript was checked at least twice by the experimenter and an assistant. From the transcripts, counts were made of the number of words and messages used by each subject. Three other measures were derived

from those counts: the average message length, the relative variability of the number of words used by a team, and the relative variability of the number of messages used by a team.

For the verbal measures, an average value was found for subjects A, C, and D. The average value was used in the analysis of variance, which will be presented later.

Words. Past research has shown that natural communication is "extremely unruly and often seems to follow few grammatical, syntactic, and semantic rules" (Chapanis, 1976, p. 45). The protocols in this study were no exception to that characterization. To deal with that unruliness, the basic definition of a word was taken from the Random House Dictionary of the English Language, College Edition (1968):

> ... a unit of language, consisting of one or more spoken sounds or their written representation, that functions as a principal carrier of meaning, is separated from other such units in writing and speech, is composed of one or more morphemes with relative freedom to enter into syntactive constructions, and is either the smallest unit susceptible of independent use or consists of two or three such units combined under certain linking conditions....

That definition was amplified with the following rules taken directly from Ford (1977) and Krueger (1977).

1. Mispronounced words were counted as words.

2. Partial and incomplete words were counted as words. For example, "silv" for silver and "whi" for which were counted as words.

3. Colloquialisms and slang were counted as words. For example, "gotta" and "yeah" were counted as single words.

4. Contractions, both standard and nonstandard, were counted as words. For example, "he's" and "what's" were counted as single words.

5. A date, e.g., "1972," was counted as one word even though it was transcribed as "nineteen-seventy-two."

6. Interjections and vocal gestures, such as "hm" or "uh" were each counted as words on the grounds that they usually convey some information. However, no attempt was made to distinguish differences between "uh" and "ah," "mm-hm" and "uh-huh," or between "hm" and "mm." Since such words are rarely articulated well, transcribing distinction among them is arbitrary at best.

7. Abbreviations and acronyms were counted as words. For example, "U" for university and "UCLA" for the University of California, Los Angeles, were counted as single words.

Messages. A message was defined as everything a subject said from the time he first started talking until he stopped or was interrupted. A message may be a word, a sentence, or a group of sentences in length.

In some instances, this definition did not make good intuitive sense. Take the situation in which, for example, subject A is speaking. If A pauses for a breath and another subject makes a very short statement, e.g., "hmmm-mm, yeah" during the pause, and then subject A starts speaking again, three separate messages would be counted. Three messages (two for A and one for the other subject) would be counted even if the pause was short, perhaps only a second or two, and even if A continued speaking without taking notice of the intervening message by changing the content of his statement. I felt that the parts of A's statement before and after the brief, interjected statement by the other subject should be counted as a single message. My rules were that if the pause was short, if the interjected message was no more than one or two words long, and if the subject who was initially speaking did not take

notice of the interjected statement, then the two segments were counted as one message.

Because some measure of the speaker's intent had to be taken, the determination of messages by this second method was made during transcription. During transcription, intent and duration of pauses were more easily determined.

However, messages were counted both ways. Analysis of the similarity of the two counts will be described in the Analysis section.

Message length. The average message length, or words per message, was the number of words used by a subject divided by the number of messages he used.

Relative variability of words and messages. Coefficients of variation, V (Peters & Van Voorhis, 1940, pp. 78-79), were calculated for the number of words and messages used by each team using the formula:

$$V = \frac{100 \times S}{M} \quad ,$$

where V is the coefficient, S is the standard deviation of the number of words or messages used by the four members of a team, and M is the mean. A small coefficient indicates that team members produced nearly equal numbers of words or of messages. A large coefficient means that some members spoke much more than others.

Switching Actions

From the switching action recording chart the following information about switching actions was obtained: the number of requests to speak, the length of time subjects had to wait after pushing their request buttons before the communication channel was opened, the number of times subjects spoke, the length of time they spoke, and the sequence of button pushes. Some of this information is redundant of information supplied by

other dependent measures. For example, the number of times subjects spoke could also be found from message counts made from transcripts. Some information was not redundant, however. The number of requests as well as the waiting time could not otherwise be obtained.

Rank Order Problem Rankings

Two sets of rankings were made for the two rank order problems to assess how much influence subject B had in the different conditions.

From the ranking data, two sets of Spearman rank order correlation coefficients, ρ , were calculated. One coefficient was computed between the consensus rank order and subject B's individual rank order. Three other correlations were also computed, one correlation between each of the other team member's individual rankings and the final consensus ranking. An average correlation was found after the correlations were transformed to product moment correlations and then to Fisher Z''s. If B's influence on the final consensus was greater than the average of his teammates, then his correlation should be higher than the average correlation of the three.

Questionnaire Responses

A questionnaire was administered to subjects after the last session. A copy of the questionnaire is shown in Appendix G.

Some questions were designed to assess attitudes relevant to this research. For example, question #1, #2, and #3 dealt with the emergence of leadership. Questions #9 and #10 asked about reactions to the switching system.

Other questions were designed to supplement information obtained by other dependent measures. For example, questions #11 and #12 dealt with perceived improvement in using the communication system which supplement several more objective measures that might have shown

an improvement over time, e.g., time to solution, quality of solution.

Four types of questions were used in the questionnaire. Wherever possible, questions which provide quantitative results were used. Quantitative questions were rating scales, rank ordering, and multiple choice questions. To amplify the quantitative information, open ended questions were often used. In some cases, however, the open ended questions were used alone.

Experimental Design

The experimental design (Table 5) was a mixed design (Myers, 1972, chap. 8) with two between-teams variables (switching and appointed helper) into whose crossed levels teams were nested, and three within-teams variables (days, problems, and roles). The role variable (subject B vs the average of subjects A, C, and D) does not appear on this table. The variables of switching and appointed helper were completely crossed. The order of presentation of the four problems was balanced across days in a Latin square format. The Latin square format was replicated for each of the four between-teams treatment level combinations.

Analyses

Table 6 shows the forms of the Analysis of Variance (Anova) used to analyze the data from the dependent measures.

Model A was used to analyze number of messages, number of words, and words per message. Model B was used for the analysis of time to solution, bonus, and coefficients of variations for words and messages. Model B differs from Model A in that the effect or role was not a source of variation in Model B because, for these three measures, each team yields only one datum per session.

Models C and D were used to analyze the strip chart data. Since strip chart data could be collected only

TABLE 5

Experimental Design

		Day 1	Day 2	Day 3	Day 4
Switched					
Appointed Helper	Team 1	P_1	P_3	P_4	P_2
	Team 2	P_3	P_2	P_1	P_4
	Team 3	P_2	P_4	P_3	P_1
	Team 4	P_4	P_1	P_2	P_3
No Appointed Helper	Team 5	P_1	P_3	P_4	P_2
	Team 6	P_3	P_2	P_1	P_4
	Team 7	P_2	P_4	P_3	P_1
	Team 8	P_4	P_1	P_2	P_3
Nonswitched					
Appointed Helper	Team 9	P_1	P_3	P_4	P_2
	Team 10	P_3	P_2	P_1	P_4
	Team 11	P_2	P_4	P_3	P_1
	Team 12	P_4	P_1	P_2	P_3
No Appointed Helper	Team 13	P_1	P_3	P_4	P_2
	Team 14	P_3	P_2	P_1	P_4
	Team 15	P_2	P_4	P_3	P_1
	Team 16	P_4	P_1	P_2	P_3

P_1 = Fire Safety and Prevention problem
P_2 = Energy Conservation problem
P_3 = National Issues problem
P_4 = University Budget problem

TABLE 6

Six Forms of the Analysis of Variance

Source of Variation	Model A d.f.	Model B d.f.	Model C d.f.	Model D d.f.	Model E d.f.	Model F d.f.
Between Teams	15	15	7	7	15	15
Switching (SW)	1	1	--	--	1	1
Appointed Helper (APP)	1	1	1	1	1	1
SW X APP	1	1	--	--	1	1
Teams/(SW X APP)	12	12	--	--	12	12
Teams/APP	--	--	6	6	--	--
Within Teams	112	48	24	56	--	16
Days (D)	3	3	3	3	--	--
D X SW	3	3	--	--	--	--
D X APP	3	3	3	3	--	--
D X SW X APP	3	3	--	--	--	--
Problems (P)	3	3	3	3	--	--
P X SW	3	3	--	--	--	--
P X APP	3	3	3	3	--	--
P X SW X APP	3	3	--	--	--	--
Role (R)	1	--	--	1	--	1
R X SW	1	--	--	--	--	1
R X APP	1	--	--	1	--	1
R X SW X APP	1	--	--	--	--	1
R X (Teams/(SW X APP))	12	--	--	6	--	12
R X D	3	--	--	3	--	--
R X D X SW	3	--	--	--	--	--
R X D X APP	3	--	--	3	--	--
R X D X SW X APP	3	--	--	--	--	--
R X P	3	--	--	3	--	--
R X P X SW	3	--	--	--	--	--
R X P X APP	3	--	--	3	--	--
R X P X SW X APP	3	--	--	--	--	--
Latin Square Error Terms (LSE)	48	24	12	24	--	--
Overall LSE	6	6	6	6	--	--
LSE X SW	6	6	--	--	--	--
LSE X APP	6	6	6	6	--	--
LSE X SW X APP	6	6	--	--	--	--
LSE X R	6	--	--	6	--	--
LSE X R X SW	6	--	--	--	--	--
LSE X R X APP	6	--	--	6	--	--
LSE X R X SW X APP	6	--	--	--	--	--
Total	127	63	31	63	15	31

Note: A dash (--) means that term is not a source of variation in the analysis of variance for that dependent variable.

for the two switched conditions, the effect of appointed helper was not a source of variation in this analysis. Model C was used for the number of requests and the average request length. Model D was used for the number of controls and the average control length.

Anova Model E was used to analyze the rating scale data from the questionnaire. The ratings from the 16 subjects in each treatment group were pooled with no distinction made between teams and roles.

Model F was used to analyze the rank data from the two issue ranking problems. The sources of variation for days and problems were not included because the two effects are completely confounded.

Before the rank correlations could be analyzed, they had to first be transformed to Pearson correlation coefficients and then to Fisher Z''s. The transformation of ρ to r' is done using the formula:

$$r' = 2 \sin \left(\frac{\rho}{6} \right)$$

with ρ in radian or pi units. The transformation of r' to Z' is done using the formula:

$$Z' = \tfrac{1}{2} \left[\log_e (1 + r') - \log_e (1 - r') \right]$$

Both formulas were found in Peters and Var Voorhis (1940).

The similarity, or dissimilarity, between the two methods of counting messages was examined by correlating the two counts using Pearson product-moment correlations. The two counts were discrepant only for the two nonswitched conditions because in the switched conditions there could be no quick interjections during pauses. Four correlation coefficients were calculated, each with 16 pairs of numbers. I had decided ahead of time that if the correlations were sufficiently high, I would perform the analyses of variance on only one count, since the other would essentially be redundant.

Whenever a significant effect was found for days or problems, tests of linear trend or a Newman-Keuls

Post Hoc Analysis was performed to explore the result further. Also, a correlation coefficient was calculated between the time teams took to solve a problem and the size of the bonus they were given.

RESULTS AND DISCUSSION

Of the 165 potentially significant effects, 32, or 19%, were statistically significant or nearly significant at $p \leq 0.05$ (Table 7). The two major manipulations of interest, switching and appointed helper, and interactions involving them account for 16 of the effects. Role was involved in six effects. Thirteen of the 32 involve the main effect of problems or some interaction of problems with another variable.

Time to Solution

Three sources of variation produced either significant or nearly significant differences in the time teams took to solve problems. Teams in the switched condition took 8.07 minutes longer to solve problems than did teams in the nonswitched condition (27.16 vs 19.09 minutes, respectively).

The second set of significant differences was attributable to Problems. The Fire Safety problem took longest to solve (42.14 minutes), the University Budget problem considerably less (19.05 minutes), the National Issues problem still less (17.95 minutes), and the Energy Conservation problem least of all (13.35 minutes).

The rank ordering of times to solve problems depends to some extent on the switching condition since the switched x problem interaction (Figure 1) approached a conventional level of significance ($p = .057$). The time required to solve three of the four problems was greater in the switched than in the nonswitched condition. The proportional differences between the two conditions were also about equal for the three problems, ranging from 31% for the University problem to 41% for the National Issues problem.

The exception to the trend was the Energy Conservation problem for which the average time to solution in the switched condition was about 27% shorter than in the nonswitched condition. A plausible explanation for this

TABLE 7

Summary of All Statistically Significant or Nearly Statistically Significant Sources of Variance Found by the 12 Analyses of Variance

Sources of Variation	Time to Solution	Quality of Solution	Verbal Measures: Number of Words	Verbal Measures: Coefficient of Var.: Words	Verbal Measures: Number of Messages	Verbal Measures: Coefficient of Var.: Messages	Verbal Measures: Words Per Message	Strip Chart Measures: Number of Messages	Strip Chart Measures: No. of Requests to Talk	Strip Chart Measures: Message Length	Strip Chart Measures: Length of Wait to Talk	Rank Data
Switching (SW)	.031				3.84×10^{-5}		3.2×10^{-6}	--	--	--	--	.020
Appointed Helper (APP)									.044			
SW x APP				.048				--	--	--		
Days (D)			6.79×10^{-3}		9.49×10^{-4}		.001	.047		.032		--
D x SW		.048					2.36×10^{-4}	--	--	--	--	--
D x APP												--
D x SW x APP				.010				--	--	--	--	--
Problem (P)	2.69×10^{-7}	10^{-10}	3.57×10^{-7}	.061	10^{-10}			6.3×10^{-6}	2.78×10^{-6}		.032	--
P x SW	.057		3.47×10^{-3}	.027	.010			--	--	--	--	--
P x APP												--
P x SW x APP								--	--	--	--	--
Role (R)	--	--	.012	--	.042	--		.011				
R x SW	--	--		--		--	.032	--	--	--	--	
R x APP	--	--		--		--						
R x SW x APP	--	--		--		--		--	--	--	--	.069
R x D	--	--		---								--
R x D x SW	--	--		--		--		--	--	--	--	--
R x D x APP	--	--		--		--						--
R x D x SW x APP	--	--		--		--		--	--	--	--	--
R x P	--	--		--		--						--
R x P x SW	--	--	.055	--		--						--
R x P x APP	--	--		--		--						--
R x P x SW x APP	--	--		--		--						--

Note: The entries are exact P values. A dash (--) means that the term is not a source of variation in the analysis of variance for that dependent variable.

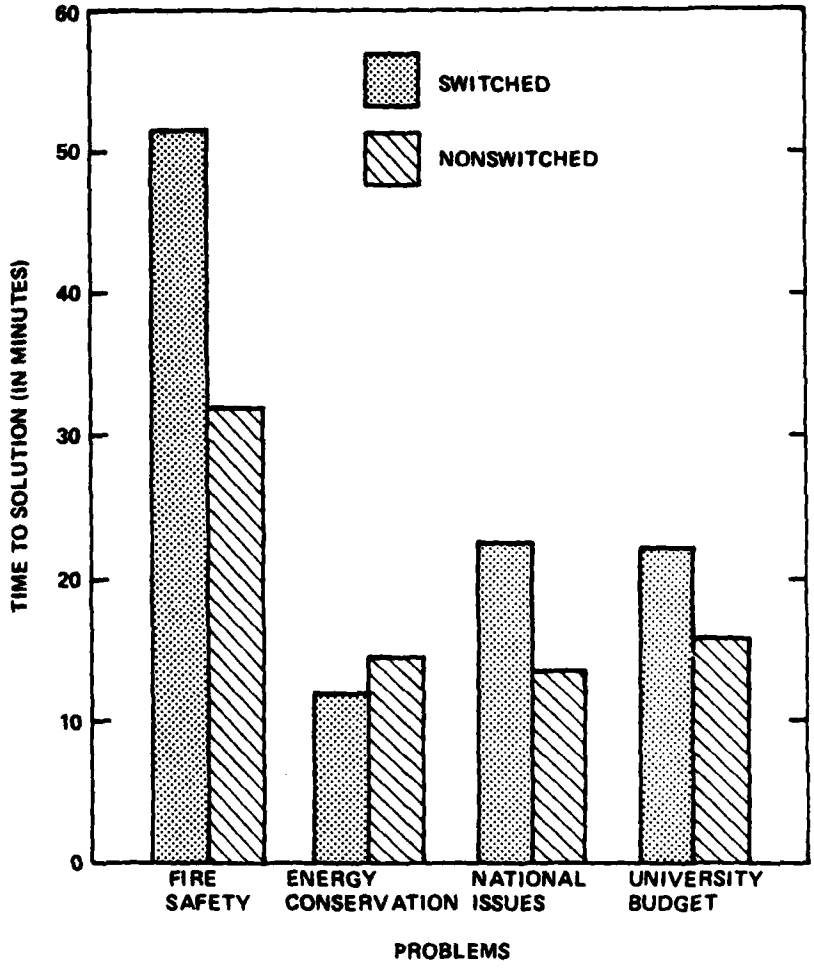

Figure 1. Average time to solution by teams that solved each of the four problems in either the switched or nonswitched conditions.

reversal comes from the research on communication networks described earlier. That research has shown that the organizational structure required to solve simple problems is trivial. Since the Energy Conservation problem was the easiest to solve as indicated by the short times to solution, the high bonuses, and the comments made by subjects, we should not expect the network to have much effect on solution time. In the case of the three more complex problems, the effect of the switching may have been to restrict the more involved communications necessary to solve these problems. No such restrictions were imposed in the decentralized or nonswitched networks. That being the case, the centralized network -- the switched condition -- should have a shorter time than the decentralized network for the three more complex problems. This explanation is supported by the significant switching x problems interaction for number of words.

Quality of Solution

Two sources of variation, problems and the interaction of switching and days, produced significant differences in the quality of team solutions to the problems.

As measured by the size of the average bonus, teams did best at solving the Energy Conservation problem ($2.31), and somewhat less well with the National Issues ($2.28), and the University Budget problems ($2.26). Teams did poorest at solving the Fire Safety problem ($1.57).

The significant switching x days interaction does not appear to be very meaningful (see Figure 2).

Relationship Between Time to Solution and Quality of Solution

A Pearson product-moment correlation between the time teams took to solve problems and the size of the bonus they received was calculated for each problem. Only one of the four correlations, that for the Fire Safety problem, was significant ($r = -.65$, $.001 < p <$

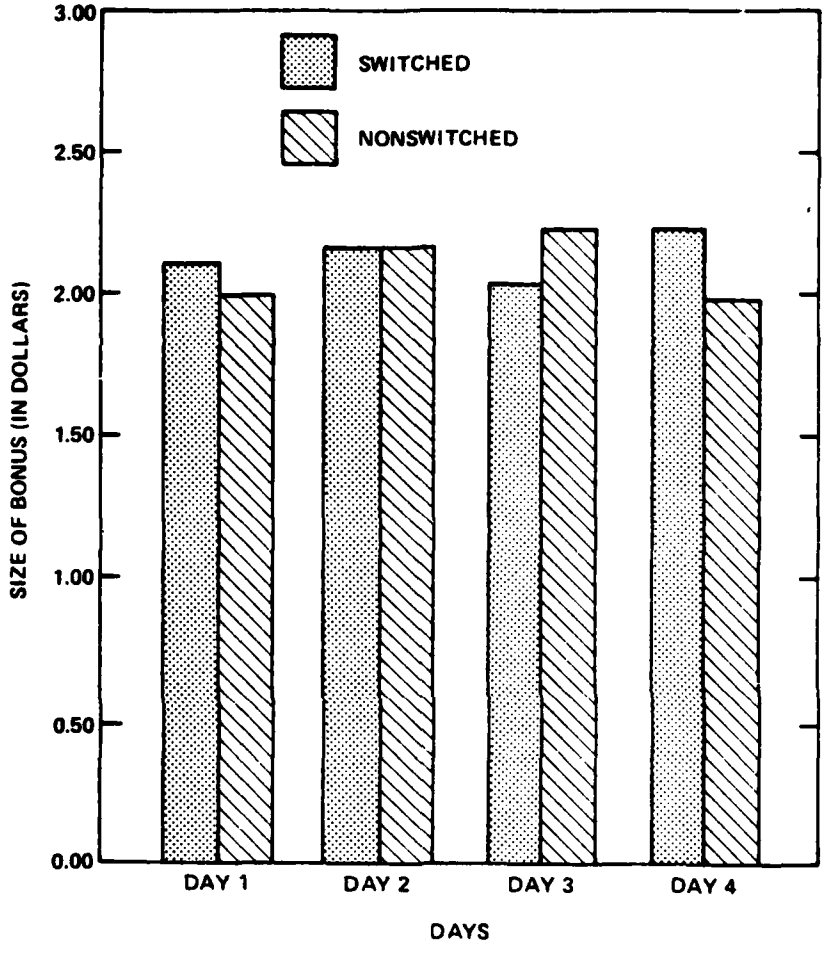

Figure 2. Average bonus earned by teams on each of the four days in either the switched or nonswitched conditions.

.01). Eliminating the most extreme data point from the scatterplot for the Fire Safety problem and recalculating the correlation yielded a negative but nonsignificant correlation (r = -.454). These results indicate there is no relationship between the time taken to solve a problem and the quality of the solution.

Verbal Measures

Words

A total of 214,067 words were spoken during the course of this experiment. The following sources of variation were significant or nearly significant: days, problems, problems x switching, role, and role x problems x switching.

There was a marked and fairly consistent decrease in the number of words used as the experiment progressed. The mean numbers of words used on the four days were 1209.3, 903.7, 971.9, and 686.9, respectively. A Newman-Keuls test indicated that the number of words used on day one was significantly greater than the number of words used on days two, three, and four. In addition, the average number of words for day three was significantly greater than that for day four. This decrease in the number of words used on successive days indicates that a considerable amount of learning took place.

Subjects used most words in solving the Fire Safety problem (1521.7 words) and successively fewer words for the University Budget problem (848.3 words), the National Issues problem (769.3 words), and the Energy Conservation problem (632.0 words). A Newman-Keuls test showed that subjects used significantly more words in solving the Fire Safety problem than they did in solving the other three problems. No other differences were significant.

The interaction of problems x switching is shown in Figure 3. This pattern of results is similar to that reported earlier for time to solution (Figure 1). The explanation given for those results also holds here.

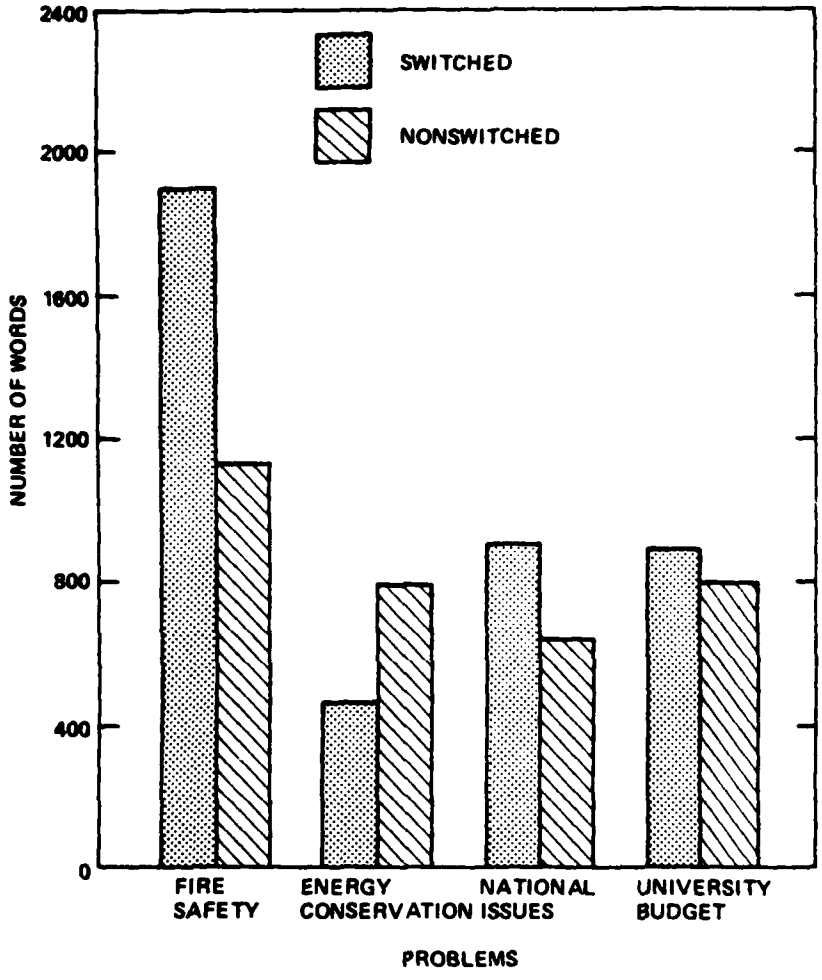

Figure 3. The average number of words spoken per subject on teams that solved each of the four problems in either the switched or nonswitched conditions.

Subject B, the switcher and/or helper, used more words than the average of his three teammates (1156.33 vs 729.54). This effect, however, has to be interpreted in the light of a triple interaction of role x problem x switching which nearly reached a conventional level of significance (see Figure 4). The expected cell values of the triple interaction were calculated and then compared with the actual cell values (Myers, 1972, pp. 102-103). The largest difference between the expected and actual cell values comes because while solving the Fire Safety problem subject B used more words than his teammates did in the switched condition but not in the unswitched condition. The number of words spoken by B and his teammates in the nonswitched condition were about equal. This shows that B's role as a moderator and a controller of conversations was most apparent in the switched condition for the Fire Safety problem.

Coefficient of Variation for Words

Four effects were significant or nearly significant for the Anova of the coefficient of variation for words: switching x appointed helper, problems, days x switching x appointed helper, and problems x switching.

The interactions of switching x appointed helper (see Figure 5) and of days x switching x appointed helper were both significant (see Figure 6). The pattern of data in the double interaction (Figure 5) is repeated on days one, two, and four in the triple interaction (Figure 6). But the pattern of the double interaction reverses on day three in the triple interaction. The expected cell values of the triple interaction were calculated and then compared with the actual values. The largest difference between the expected and actual cell values comes because of the reversals on day three. The reason for these two reverses is not clear.

The main effect of problems was nearly significant and the interaction of problems x switching was significant (see Figure 7). A test for extreme means applied to the eight averages in Figure 7 showed that the average value for the Fire Safety problem in the switched condition was significantly greater than the other

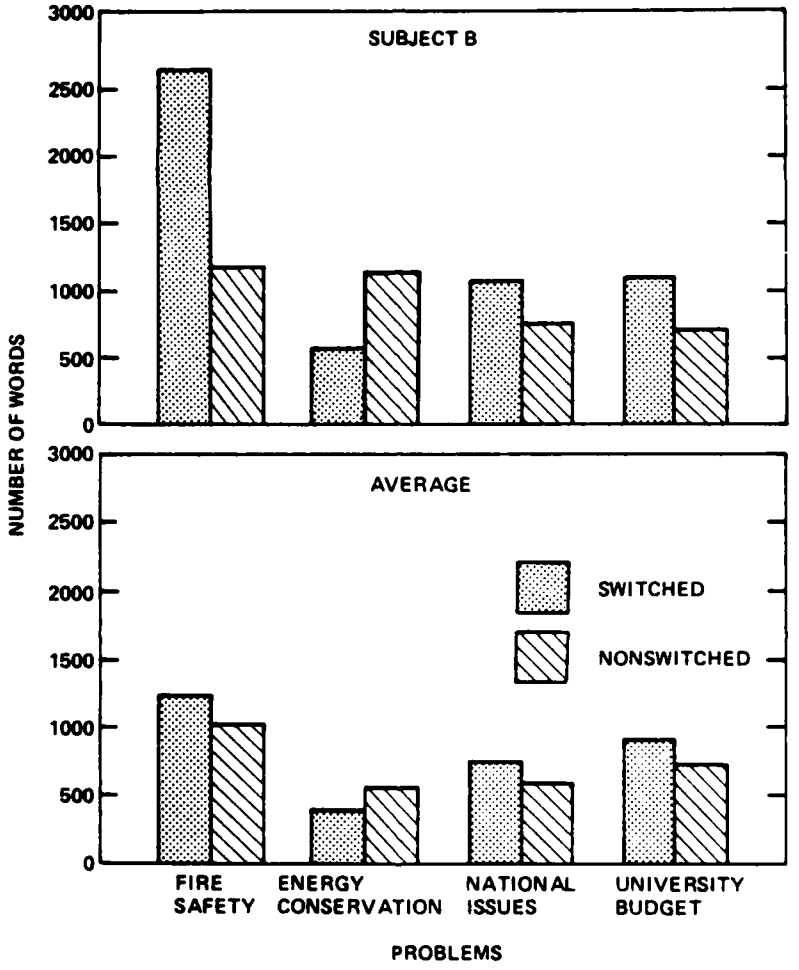

Figure 4. Average number of words spoken per subject on teams that solved each of the four problems in either the switched or nonswitched conditions. The upper half of the figure shows average data for the one subject on each team who was in charge of the switching mechanism; the lower half shows average data for the other three subjects on each team.

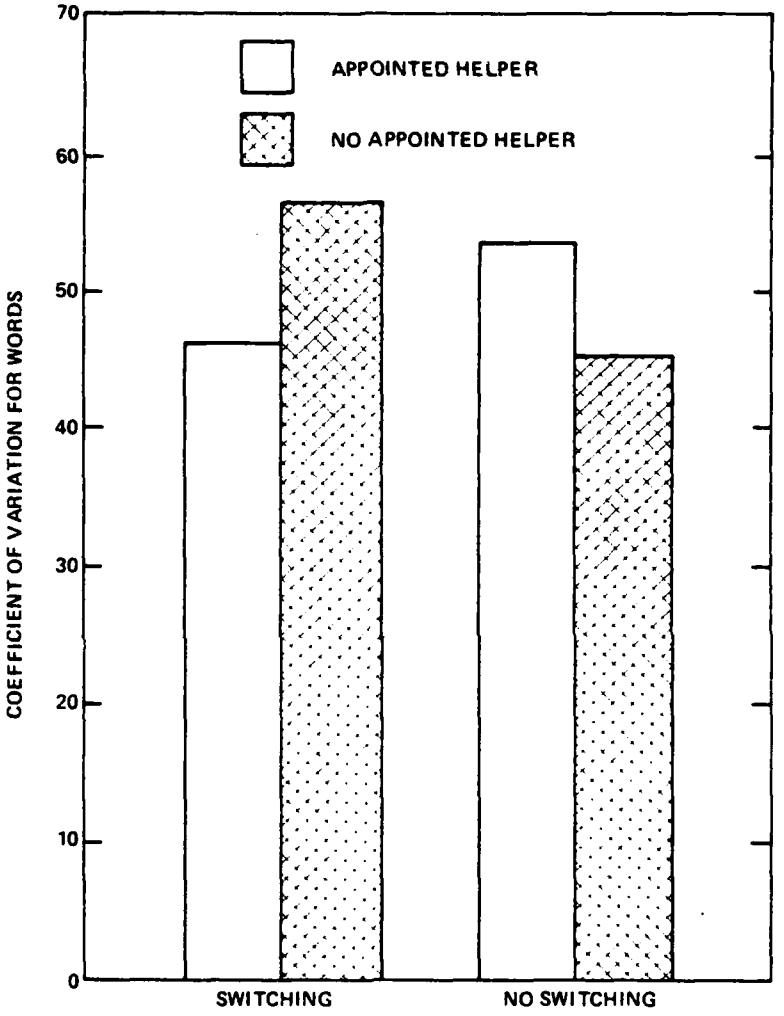

Figure 5. Average team coefficients of variation computed for the number of words spoken by each of the four subjects on a team. The bars show data for those teams that worked in either the switched and nonswitched conditions and either with or without an appointed helper.

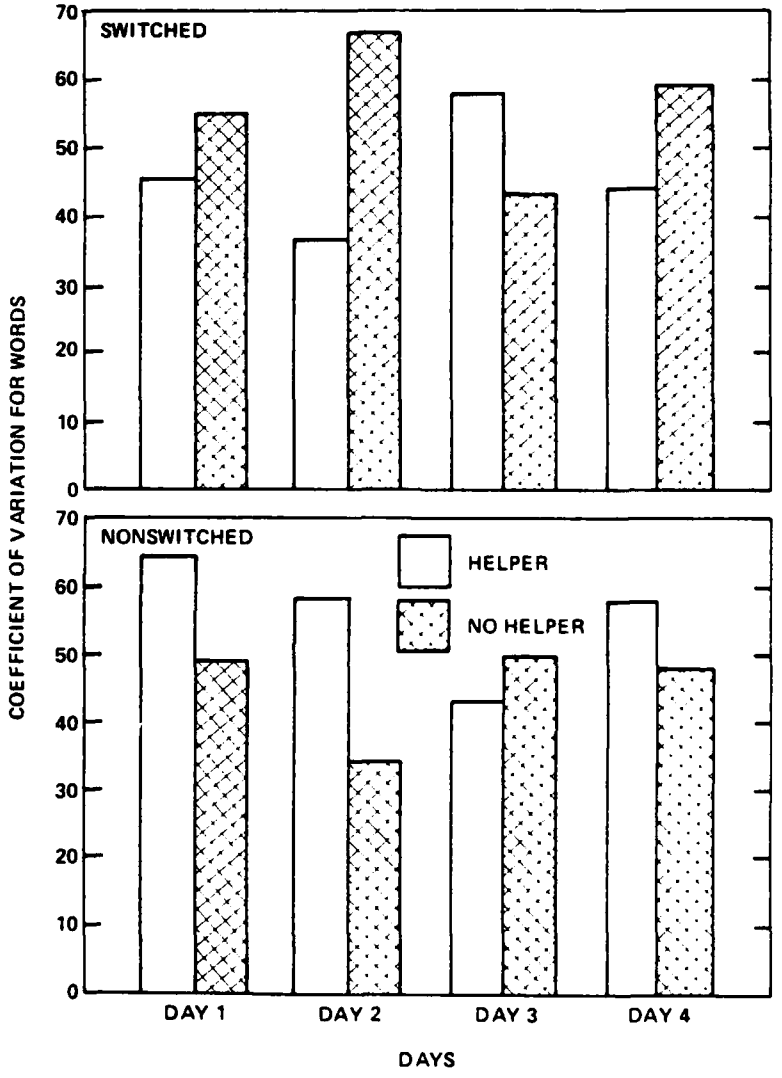

Figure 6. Average team coefficients of variation computed for the number of words spoken by each of the four subjects on a team. Data are given for the four days on which teams worked and are shown separately for those teams that worked with or without an appointed helper. The upper half of the figure is for teams that worked in the switched condition; the lower half for teams that worked in the nonswitched condition.

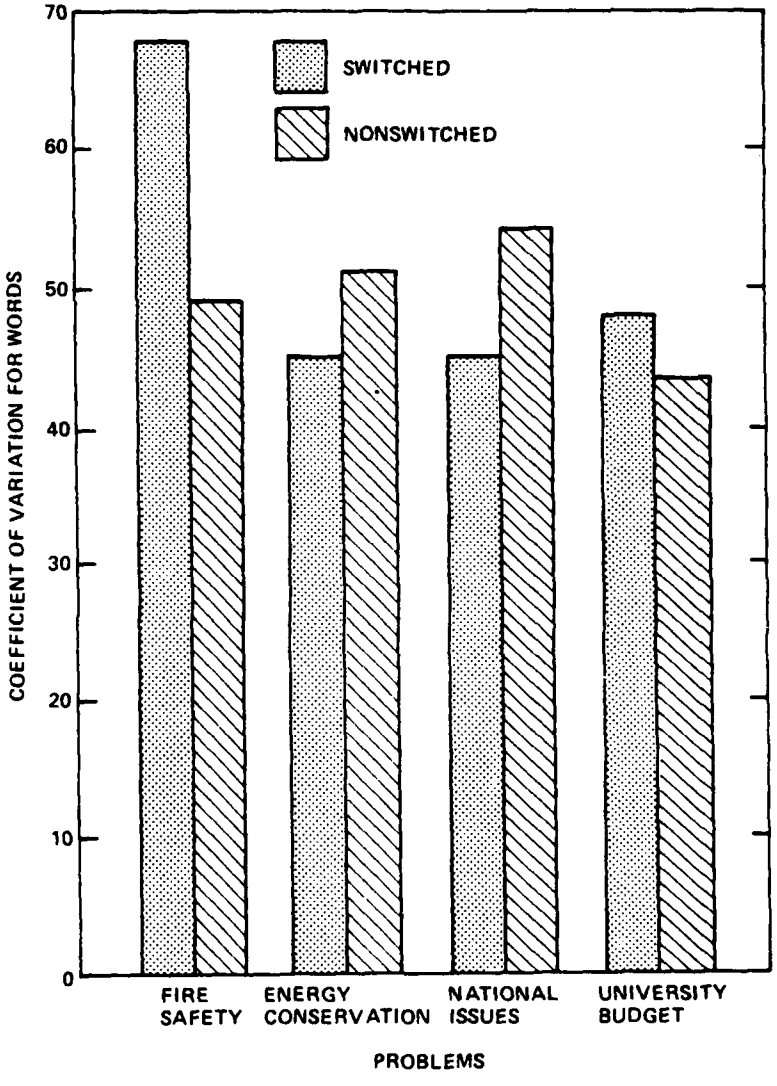

Figure 7. Average team coefficients of variation computed for the number of words spoken by each of the four subjects on a team. Data are given for teams that solved each of the four problems in either the switched or nonswitched conditions.

seven. Figure 4 showed that on the average B spoke more than his teammates. Moreover, the difference between what B spoke and what his teammates spoke was quite large in the Fire Safety problem in the switched condition, i.e., B dominated the conversations to a greater extent in this one instance than he did in any other of the seven conditions. This was the case for five out of the eight teams in the switched condition. Since Figure 7 shows coefficients of variation, the discrepancy between what B and the other subjects did shows up as a large coefficient for that problem and that condition. The open-ended and unstructured nature of the Fire Safety problem seemed to increase the need for B, by virtue of his central position in the communication network, to dominate the discussions, to structure the communication, and to direct the problem solving.

Messages

The main effect of switching was highly significant. On the average, subjects in the switched condition spoke 21.7 times while those in the nonswitched condition spoke 80.4 times. This fourfold difference, as well as the nonsignificant difference in the number of words used in the two conditions, will be discussed later in the section on words per message.

The number of messages decreased in a regular way from day to day. On the average subjects used 63.3, 55.0, 45.7, and 40.1 messages on the four consecutive days. A post hoc test for trend revealed a highly significant linear component ($p < .001$), but no significant quadratic or cubic components. These data and the number of words used on successive days clearly indicate some learning and adaptation to the test situation.

The main effect for problems was highly significant. Subjects used 82.1 messages in solving the Fire Safety problem, and 32.8, 41.1, and 48.2 messages in solving the Energy Conservation, National Issues, and University Budget problems, respectively. A Newman-Keuls test showed that subjects spoke significantly more often in solving the Fire Safety problem than the other three problems. No other difference was significant.

This finding is consistent with other significant problem effects and shows that the solution of the Fire Safety problem required much more verbal interaction than did the other problems.

The interaction of problem x switching is shown in Figure 8. Comparison of the expected cell values with the actual cell values showed that the largest single contribution to the interaction comes because far too few messages were used by the teams that solved the Fire Safety problem in the switched condition and far too many messages were used by teams that solved the same problem in the nonswitched condition. That is, the difference between the number of messages used in the switched and nonswitched conditions is biggest in the Fire Safety problem.

The main effect of role was also significant. Subject B spoke more often than the average of his three teammates, 57.1 vs 45.0 times, respectively. The difference can be attributed to B's efforts to carry out his duties as switcher and/or helper.

Coefficient of Variation for Messages

No significant effects were found for the Anova on the coefficient of variation for messages.

Relationship Between the Two Message Counting Methods

The four correlations between the two methods of counting messages (page 27) were very high, ranging from +.983 to +.997, and were significant well beyond the $p = .001$ level of significance.

The percentage difference between the two methods ranged from 0.0% to 26.3% (mean = 8.6%) with my method of counting yielding lower counts than the previously used method.

On the basis of the two sets of calculations I conclude that both methods give essentially the same results with a tendency for my method to yield smaller

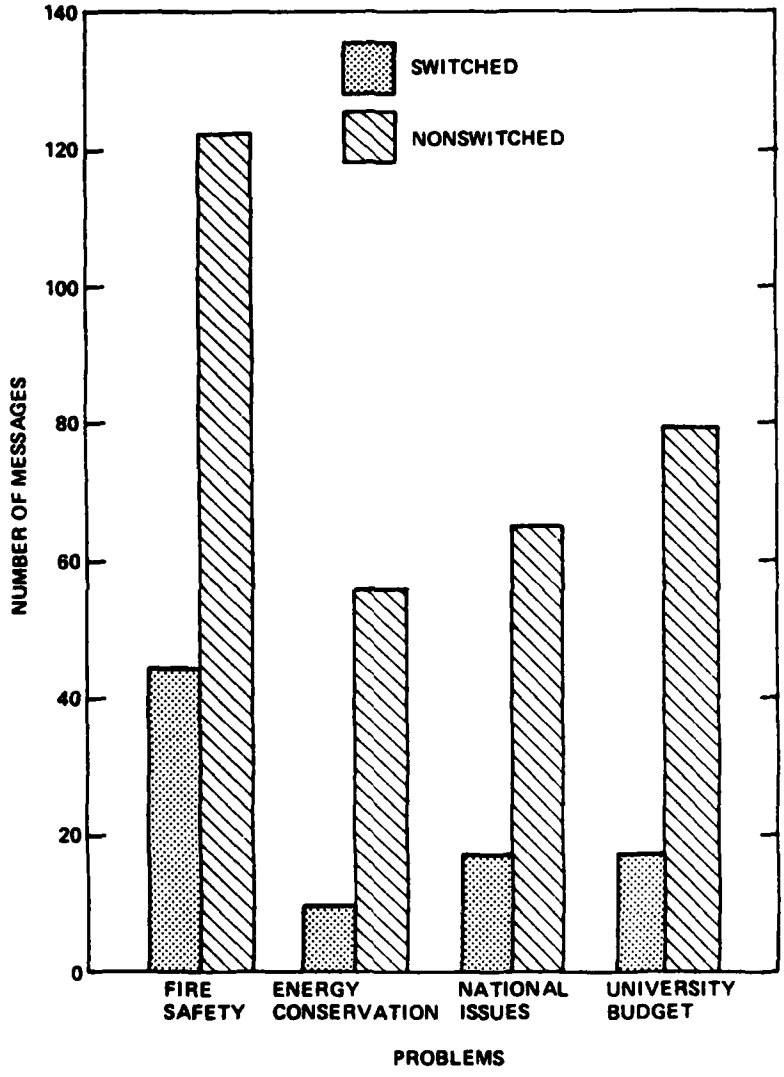

Figure 8. Average number of messages spoken per subject on teams that solved each of the four problems in either the switched or nonswitched conditions.

counts. While my method uses a more intuitive definition of what constitutes a message, it is not as easy to use as the older method. As a result, I would favor using the older method.

Words Per Message

The following sources of variation were significant for the Anova on message lengths (words per message): switching, days, days x switching, and role x switching.

In the analysis of variance on words (page 40), switching was not a significant source of variation. This means that subjects used about the same number of words in the switched and nonswitched conditions. At the same time, subjects in the nonswitched condition used four times as many messages as did subjects in the switched condition. These two findings together imply that message lengths must have differed in the two conditions, which was indeed the case. Subjects in the switched condition used 10.4 words per message while subjects in the nonswitched condition used 49.6 words per message, an almost fourfold difference. Another way of describing these findings is that subjects use about the same number of words to solve problems whether they experience communication control or not. Subjects in the two conditions do, however, package their communications differently. The most likely reason for this is that subjects in the switched condition experienced more difficulty in being allowed to speak. Since only one subject could speak at a time, each had to wait his turn after pressing the "Request to Talk" button. Moreover, they were not free to interrupt one another. As a result of these constraints subjects spoke less often but said more when they did speak.

Although the main effect for days was significant, the more important finding is that the pattern of change on successive days is different for the two switching conditions (see Figure 9). Overall, subjects used 24.4, 29.6, 35.6, and 30.4 words per message on the four successive days. In the nonswitched condition, however, message lengths are very nearly uniform. In the switched

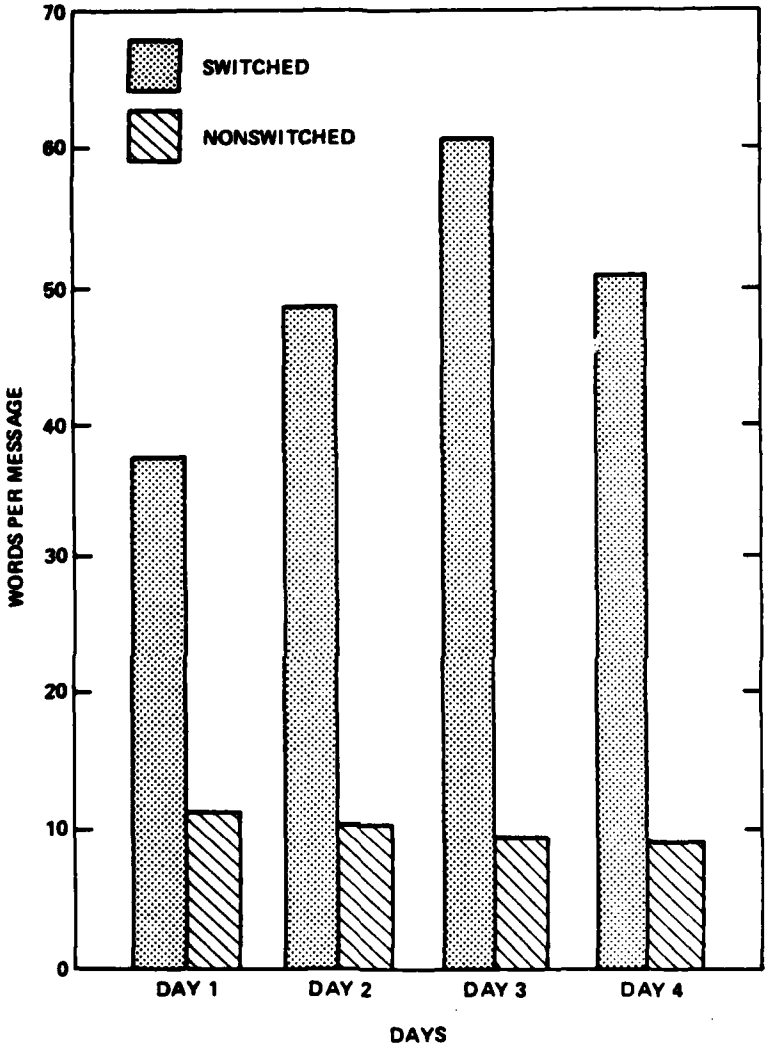

Figure 9. Average message lengths by subjects on teams that worked on four successive days in either the switched or nonswitched conditions.

condition, the number of words per message generally increases on successive days, despite the one reversal between days three and four (the means are 37.5, 48.5, 61.1, and 51.3, respectively). The packaging effect becomes more pronounced as subjects learn to use the switching system. One thing they are learning, presumably, are the consequences of their inability to interrupt another speaker. Once a subject in the switched condition finished speaking and lost the floor, he usually had to wait before being allowed to speak again. One way to compensate was to speak completely and exhaustively while he had the channel. It is as though subjects have a set amount to say and that one way or another they were going to say everything they had to say (remember that there is no difference between the switched and nonswitched conditions in the total number of words spoken). Subjects will interrupt freely if they are allowed to do so. However, if they cannot interrupt at will, they will speak less often but say more each time they are allowed to speak.

The significant interaction of role x switching (see Figure 10) shows that in the switched condition, subject B used slightly fewer words per message than did his three teammates, 46.0 vs 53.2 words, respectively. In the nonswitched condition, B used slightly more words per message than his teammates did. In the switched condition many of B's messages seemed to consist of his telling teammates that it was their turn to speak. These messages tended to be short and, of course, this kind of prompting was not done by the other subjects.

Strip Chart Measures

Strip chart recordings were made only for the switched condition. In addition, the counts of the number of messages obtained from the strip chart differ slightly from the counts obtained from the transcripts. The discrepancies occur because subjects occasionally did not speak when the communication channel was open for them to speak. Sometimes, for example, B pushed a button by mistake and then quickly pushed the correct one. Sometimes subjects had nothing to say or were not

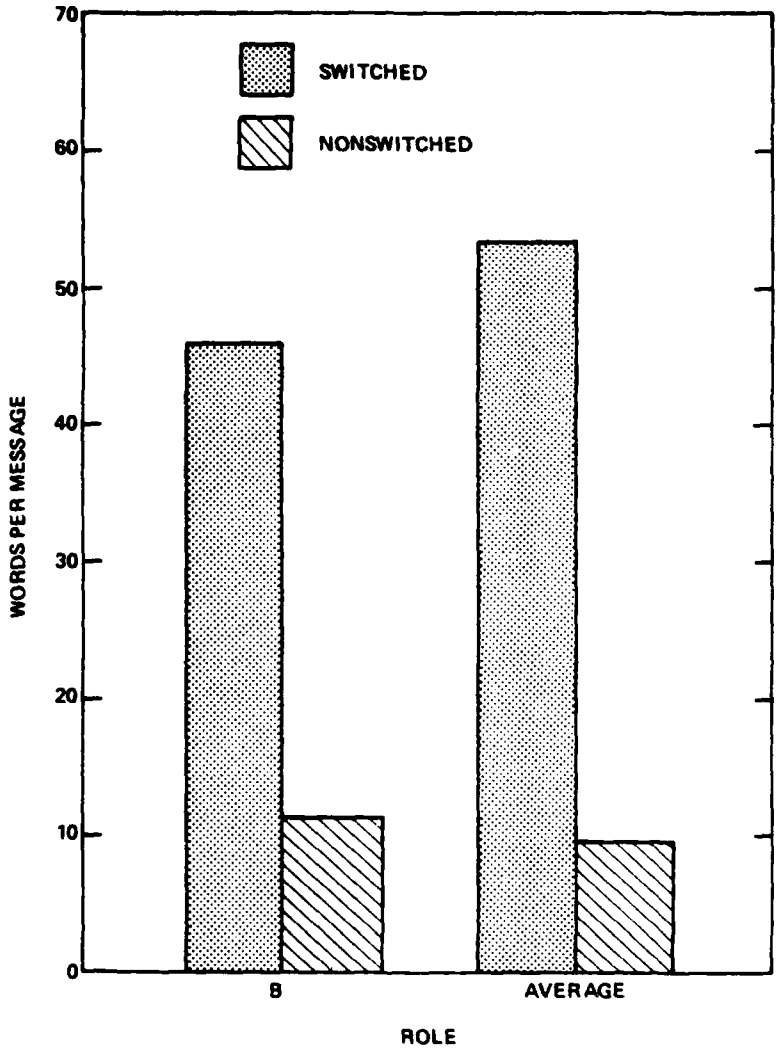

Figure 10. Average message lengths spoken by the one subject (B) on each team who controlled the switching mechanism and by the other three subjects (Average) on each team. The data are shown separately for teams that worked in either the switched or nonswitched conditions.

looking at their control boxes and had to be prompted by B. When a subject did not speak, for whatever reason, the silence was not counted as a message on the transcript. However, a record of the button push was made on the strip chart and was counted as a message.

Number of Messages

Three effects were significant for messages counted from the strip chart recordings: days, problems, and roles. All of these results are consistent with those found from the analysis of the number of messages counted from the transcripts.

The main effect for days was marginally significant. Subjects spoke more often on day one than on the other three days. The results for days two, three, and four appear to be about equal. However, a Newman-Keuls post hoc analysis failed to show any significant difference.

The main effect for problems was highly significant and the data parallel almost perfectly the switched data in the problems x switching interaction (Figure 8).

The significant main effect for role is similar to the comparable effect obtained when messages were counted from transcripts (pages 47-48).

Number of Requests to Talk

Two main effects were significant in the data on number of requests to talk: appointed helper and problems.

Subjects in the non-appointed helper condition made significantly fewer requests to speak (34.6) than did those in the appointed helper condition (47.6). The explanation for the difference lies in comparisons between the total number of requests to talk and the total number of times subjects spoke. For each team, the difference between the two numbers should be small if the difference were accounted for only by inadvertent button

pushes. Inadvertent button pushes should not only be few in number but they should also be evenly distributed across teams and sessions. The eight average differences in Table 8 were rank ordered and a test of extreme means was applied to them. The large value for team 5 was found to be significantly different from the other means whereas the next highest mean was not. Since the average difference for team 5 is not small, some explanation other than inadvertent button pushes must be found to account for it. A study of the transcripts shows that subject B in team 5 typically opened his teammates' communication channels without waiting for them to make a request to talk. In other words, B in team 5 took his leadership role much more seriously than did comparable subjects on all the other teams. He was very much in charge and he controlled the communication flow to an unusual extent deciding when his teammates would speak.

Subjects made more requests to speak in solving the Fire Safety problem (75.5) than in solving the other three problems, 19.9, 36.1, and 32.6 for the Energy Conservation, National Issues, and University Budget problems, respectively. This finding is consistent with the results of the analysis for messages reported earlier.

Average Message Length

One effect was significant for the Anova of average message lengths. Average message length increased from day one to day three in a regular manner and then dropped off slightly on day four (17.86, 21.06, 25.44, and 23.33). A significant linear trend was found ($p = .013$). No significant quadratic or cubic components were found.

Average message length is a ratio of the total time a subject's communication channel was open to the number of pen deflections. The number of words per message is a ratio of the total number of words spoken by the subject to the number of messages counted on a transcript. Both ratios, therefore, represent the average length of communication per communication act, and data for both measures are similar (see those on pages 50-52 and in Figure 9).

TABLE 8

Difference Between the Number of Times Subjects Spoke and the Number of Requests They Made to Speak

Appointed Helper

Team	Session 1	2	3	4	Average	Rank Order
1	1	0	6	0	1.75	7
2	0	1	3	3	1.25	8
3	3	2	1	6	3	4.5
4	0	10	0	2	3	4.5

No Appointed Helper

Team	Session 1	2	3	4	Average	Rank Order
5	75	24	18	1	29.5	1
6	6	3	4	1	3.5	3
7	5	2	6	5	4.5	2
8	1	3	4	0	2.0	6

Average Request Length

Only the main effect for problems was significant for the average length of time subjects had to wait after pressing their "I WANT TO TALK" button before they were allowed to speak. A Newman-Keuls test showed that this time was significantly larger for the University Budget problem than for the Fire Safety problem. No other difference was significant. The reasons for these results are not clear.

Rank Correlation Measure

Two sources of variation were significant or nearly significant in the Anova of the data of the rank correlation between the individual rank orderings and the final consensus rank order: switching, and the interaction of role x switching x appointed helper.

The average rank correlation for the switched condition was significantly lower than the average rank correlation for the nonswitched condition, +.66 vs +.76, respectively. Subjects in the switched condition did not match their rank orderings with the criteria as well as did subjects in the nonswitched condition. Interpretation of this finding must be cautious because no difference between the two conditions was found for the quality of solution measure which used data for all four problems, not just the two rank ordering problems. The results from some of the communication network studies are also inconsistent. Of ten studies which examined the number of errors made while teams solved complex problems, six studies found that teams in centralized networks made more errors than teams in decentralized networks, one found that teams in decentralized networks made more errors than teams in centralized networks, and three showed no difference.

The nearly significant interaction of role x switching x appointed helper is shown in Table 9. One prediction had been that B, having special assigned responsibilities, should have more influence than his teammates. The rank correlations appear to show that this was not so. In the nonswitched condition, the average

TABLE 9

Average Rank Correlations for the Eight

Role x Switching x Appointed Helper Combinations

	Switching		No Switching	
Role	Appointed Helper	No Appointed Helper	Appointed Helper	No Appointed Helper
B	.53	.73	.77	.75
Average	.64	.72	.77	.75

Note: Average stands for the average of subjects A, C, and D.

rank correlations for B and his teammates are nearly equal. The correlations are also approximately equal in the switched-no appointed helper condition. The largest difference between the two correlations is found in the switched-appointed helper condition and the direction of the difference is contrary to predictions. My interpretation is that the difference is not due to anything inherent in the condition itself but rather is caused by the personalities of the subjects chosen to be subject B. Because subjects were assigned to experimetal rooms, several particularly quiet and unassuming subjects happened to have been assigned to room B. Based on notes made by the experimenter, these subjects could be described as passive subjects who did not press their point of view. Based on the notes made by the experimenter, more passive subject B's were found in the switched-appointed helper condition than in the switched-no appointed helper condition or in the nonswitched condition. If these observations are correct, factors other than those manipulated in this experiment, e.g., the personality of the subjects, should be considered in systems of this kind.

Another explanation for the data of Table 9 is not based on personality but on information overload or saturation. Because B had more duties to perform, particularly in the switched-appointed helper condition, one could reason that he was unable to argue as effectively for his point of view as his teammates were. It could be that either switching or helping the experimenter by themselves are not a sufficiently great burden to encumber B. However, taken together they may have an impact on B's effectiveness.

Questionnaire Responses

Question #1: *Rank order your team's members, including yourself, on each of the following....*

The six items used for this question were chosen because research on leadership has shown that leaders contribute most to and participate most in group discussions, introduce many new and good ideas, and are concerned with getting the job done and with sustaining

the social climate in the group.

For each item, the total number of first place votes a subject received was multiplied by four, second place votes were multiplied by three, third place votes by two and fourth place votes by one. The point totals were added across teams within a condition for each subject. The point totals for subject B and for the average of A, C, and D are shown in Table 10.

The most striking thing about the data in Table 10 is that subject B is rated much higher than his teammates in the switched-no appointed helper and in the nonswitched-appointed helper conditions. The ratings for the other two conditions vary quite a bit with B sometimes being rated higher than his teammates and sometimes not. What this indicates, I think, is that there were clear personality differences among the subjects who served as B in the different conditions. These differences may have attentuated the effect of switching and helper as means of becoming a group leader. That switching and helping had less effect than anticipated is clearly shown in the responses to question #3.

Question #2: For the discussions your group held, did a leader seem to emerge?

In response to this question, subjects were allowed to cast multiple votes if they felt that more than one teammate emerged as leader. They were also allowed to vote for themselves. Table 11 shows that of the 101 votes cast, 15 were cast for the "no leader" choice. Of the 86 remaining votes, almost half, or 34, were cast for subject B. One of the hypotheses had been that B should emerge as leader because of his special status. In the three conditions in which B received special powers, switching and/or helping the experimenter, B did in fact receive more votes than his teammates. This effect was most pronounced in the switching x no appointed helper and no switching x appointed helper conditions and is present but less pronounced in the switching x appointed helper condition. It is surprising that the difference was not greater in the switching x appointed helper condition since the combination of

TABLE 10

Summary of Ratings for Question #1

	Switching				No Switching			
	Appointed Helper		No Appointed Helper		Appointed Helper		No Appointed Helper	
Item	B	Average	B	Average	B	Average	B	Average
Overall contribution to the discussion	37	41.0	50	36.3	55	35.3	39	38.0
Number of ideas introduced during the discussions	26	38.0	50	36.7	51	35.3	31	40.3
Quality of ideas introduced	32	37.3	49	37.0	48	36.3	40	40.0
Amount of participation	39	37.0	57	34.3	52	37.3	35	39.3
Concern for getting the job done	38	34.0	46	35.7	54	31.0	32	43.7
Concern for the social climate in the group	55	28.7	38	24.0	41	33.0	36	35.3

Note: Higher overall ratings are indicated by higher scores.

TABLE 11

Votes Cast in Response to Question #2

on the Emergence of a Leader

	Number of votes cast for each choice				
	No Leader	A	B	C	D
Sw x App	2	6	8	7	3
Sw x Napp	5	1	10	4	3
Nsw x App	3	4	10	0	6
Nsw x Napp	5	4	6	8	6
SUM	15	15	34	19	18
% of 86		17.44	39.53	22.09	20.93

Note: Subjects were allowed to cast multiple votes.

switching and helping variables was supposed to have made B's position very influential. B's failure to emerge as leader in this condition may be due to the personality variable mentioned earlier and the finding here is consistent with those in Table 10.

Question #3: Why do you feel the individual(s) you chose in the previous question was (were) leader(s)?

The 74 reasons given to explain the choice of leader made in question #2 can be classified in four categories. Quantity of verbal output was used as a reason 11 times. Examples of such reasons are "talked most" (subject C, team 3), "participated most" (subject C, team 18), and "amount of verbal contributicn" (subject D, team 14).

Some aspect of quality was used 11 times. In this context, quality referred to the quality of ideas and contribution, for example, "made the most constructive suggestions" (subject B, team 10) and "came up with the most poignant points" (subject D, team 4).

Subjects mentioned contributions to the group process 36 times. Examples include "...in regulating discussion such that opinions were channeled constructively towards decision making; in establishing a structure which facilitated decision making" (subject A, team 4), "was always the first to suggest a mode of operations" (subject C, team 8), and "did organizing, coordinated answers" (subject A, team 3).

Sixteen reasons referred to the switching or appointed helper variables. Examples are, "He was in control of the Box" (subject B, team 5), "controlled the TV's" (subject D, team 5), "B was in control of the order in which the participants were able to voice their opinions" (subject C, team 8), and "He was chosen as aide to the experimenter which in the course of the discussions gave him an edge over the others" (subject C, team 15).

B was chosen as a leader 28 times in the three conditions in which he had some sort of power. Of the 28, 11 mention his switching function and six mention his helping responsibilities.

It is interesting that while the switching and helping responsibilities were mentioned as reasons why subjects emerged as leaders, they were not the most frequently used reasons. Moreover, when they were used, they were often used in conjunction with some other reason. This indicates that the two major independent variables in this study had only a modest influence on the emergence of subject B as a leader.

Question #4: How much were (would) discussions (have been) affected by having someone control who talked and when they talked?

Two forms of question #4, one for the switched and one for the nonswitched condition, were analyzed separately for the subjects in the appointed helper and no appointed helper conditions. A t-test showed that teams with an appointed helper in the switched condition rated the effect of switching about the same as did teams with no appointed helper (3.34 vs 3.13). Results of a t-test in the nonswitched condition gave similar results (4.31 vs 4.13).

Of 29 subjects who made comments about the effect of switching in the switched condition, six made neutral comments. Eleven rated the switching unfavorably and 12 rated it favorably. Since the comments were essentially similar to those made in response to question #9 and #10, examples of comments will be given when those questions are discussed.

In the nonswitched condition, comments about switching make a much clearer pattern. Five subjects made no comment, six rated the hypothetical effect of switching positively, and 24 rated it negatively. Clearly, subjects who had not used switching and communication control rated its effects much more negatively than subjects who had used it.

Question #5: How much easier might your tasks have been if you had met face to face?

Although the 2 x 2 factorial Anova of the rating scale responses to this question yielded no significant effects, subjects in the switched-appointed helper

condition rated face to face as being potentially better than subjects in the other three conditions (2.56 vs 1.75, 1.75, and 1.88).

Question #6: How much easier might your tasks have been if you had met over the telephone?

The 2 x 2 factorial Anova yielded no significant differences. The average ratings for the four conditions were about equal, ranging from 1.13 (nonswitched-appointed helper condition) to 1.87 (nonswitched-no appointed helper condition). These ratings were, however, slightly lower than for face to face (question #5).

Question #7: How conscious were you that you were being observed and that your conversations were being recorded?

The 2 x 2 factorial Anova revealed no significant effects. Subjects in each of the four conditions were about equally aware, or unaware, about being observed and being recorded.

Since the overall average rating was 2.81, subjects were moderately aware of the experimental environment.

It would be interesting to know how subjects who had communicated face to face would answer this question. The communication equipment and the use of the switching system might serve to increase the "consciousness" of subjects to the experiment. Subjects communicating face to face might be less conscious of the experimental situation.

Question #8: How well do you like communicating this way?

The 2 x 2 factorial Anova showed that subjects in the switched condition like communicating more with the system they had used than did subjects in the nonswitched condition ($F = 4.58$, $df = 1.60$, $p = .036$). The difference was small, however, with an average rating of 4.91 for the switched condition and 4.25 for the nonswitched condition. The reasons why subjects liked and disliked each communication system are examined in questions #9

and #10.

Question #9: What did you like about communicating this way?

Judging from comments made in questions #9 and #10, subjects generally liked communicating with the telecommunication apparatus more than they disliked it.

Comments can be divided into a number of categories. Subjects in the switched condition said they liked that system most because everyone could be heard fully with no interruptions (16 comments). For example, one subject commented, "The conversations were orderly -- few interruptions and each person heard all of the others' story" (subject C, team 4). Other comments of this type include, "It enabled everyone to talk without fear of being interrupted" (subject B, team 8), "It was controlled: every person got their recommendations in. It was polite, no interruptions and it, the experiment, was more quick and finalizing" (subject D, team 17), and finally, "Only one person could talk at a time, which is difficult to control otherwise" (subject D, team 10).

A number of other reasons were given, though less often. Subjects liked the equal opportunity to speak (three comments), the stifling of unnecessary communications (twice), the lack of pressure to speak (twice), not having to face teammates directly (three times), the novelty and fun of using the system (seven times), and the ability to see the others talking, unlike telephone (three comments).

Subjects in the nonswitched condition said they liked that communication system principally because of the feedback gained in being able to see and hear others (nine times), and the freedom of expression (eight times). Other reasons include the similarity with face to face communication (three times), the spontaneity and openness of the communications (three times), the fast and efficient problem solutions they experienced (three times), and freedom from distraction (once).

Overall, the reasons subjects gave for liking the telecommunication system are mixed. No reason stands

out as being much more important than the rest except the freedom from interruptions in the switched system.

Question #10: What did you dislike about communicating this way?

No comment was made more than six times and many comments were made only once.

Some dislikes from subjects in the switched condition seem to center around the switching system and its effects on the communication. Several subjects disliked having to wait to speak (three times) and the lack of quick feedback (three times). An example of the former is, "Only that once in a while I had to wait a short time before interjecting what I considered an essential point" (subject D, team 18), and of the latter is, "Can't see people's reaction to what you say when you say it" (subject D, team 10).

Subjects also disliked not seeing to whom they were talking (six times), being on camera (five comments), the lack of humor (once), the impersonal nature of the communications (once), the lack of argumentation (once), and the tyranny of subject B (once).

In the nonswitched condition, several comments pertained to aspects of the audio and video systems which could be corrected in a real system. For example, several comments on technical problems (three comments), the lack of eye contact (twice), and the presence of the camera and microphone (five times). Others reported feeling a Big Brother syndrome (three times). Other comments concerned the impersonal nature of the communications (five times), the lack of conflict (once), physical separation (twice), and the lack of physical or visual contact (four times).

The very aspects of the telecommunication system which some subjects liked were disliked by others. For example, some subjects liked the orderliness which resulted from the switching, but others disliked the switching because they had to wait to speak or because they lacked immediate feedback to comments. Likewise, some subjects like the freedom of expression due to

separation between individuals while others complained about the lack of contact.

Despite the inconsistency of the comments, more subjects seemed to like communicating over the system than disliked it. There also seemed to be a slight preference for the switched condition though this could be due to the novelty of the situation.

Question #11 and #12: How much did your team seem to improve in its ability to use this communication equipment (#11) and in its ability to solve the problems (#12)?

These questions will be considered together because many subjects appeared to interpret them as being the same question. The responses to the open ended part of each question are virtually identical.

Neither 2 x 2 factorial Anova yielded significant results. The average ratings for the two questions were identical.

Responses by all subjects, irrespective of the condition to which they were assigned, show that in successive sessions they felt they solved problems faster, were more methodical in their problem solving, became more relaxed and less self-conscious.

Question #13: Could your team have done better if it had had a different number of people in it?

The average rating for this question was 3.6 and the 2 x 2 factorial Anova revealed no significant differences among the four major groups of subjects. Subject opinions were evenly divided about this question. If there was a clear cut opinion it was that four man teams are pretty good.

Question #14: Was there anything that kept your team from performing at its best?

Responses to this question proved to be quite a hodge podge with no pattern emerging. They included a fear of offending people, self-consciousness, getting

up too early (even though it was their choice!), and the Russian flu. In short, responses to this question revealed little of interest.

Question #15: How well did you know each of your teammates before this experiment began?

To analyze the ratings from this question and question #16, friendship rating scores were calculated for each pair of subjects on a team. A friendship rating score is the average of the mutual ratings for each pair of subjects. For example, if subject A gave a 5 rating for subject B and B gave a 3 rating for A, the average of 5 and 3, or 4, would be the friendship rating for the A-B pair. The higher the rating, the higher the degree of perceived friendship between the two subjects. Each team contributed six scores to the 2 x 2 factorial Anova used to analyze the data.

The Anova yielded three significant or nearly significant effects. Teams in the switching condition had significantly lower average friendship ratings than did teams in the nonswitched condition ($p = 0.00099$). Teams with appointed helper had significantly lower average friendship ratings than did those in the no appointed helper condition ($p = 0.0040$). Finally, the interaction of switching with appointed helper was nearly significant at $p = .07$.

Examination of the pattern of results showed that two teams in the nonswitched-appointed helper condition had much higher average friendship ratings than the other 14 teams. A test for the extremeness of the two means showed that both were significantly larger than the rest. The most extreme mean, the mean for team 16, was significantly different from all the rest at $p = .01$. The other, the mean for team 6, was significantly different from the remaining 14 ($0.01 < p < 0.05$).

That being the case, it was natural to ask whether the presence of friends on these two teams caused them to behave differently than teams that were not composed of friends. The behavior of the two suspect teams was compared to the behavior of other teams on a number of dependent measures: time to solution, size of bonus,

number of words and messages. Both teams were compared with the two other teams in the nonswitched-appointed helper condition and also with all the teams in the nonswitched condition. Whenever teams 6 or 16 were found to be extreme outliers, a test of extreme means was applied to determine whether the mean, or means, was significantly different from the rest.

Although both teams had the lowest average times to solution, the difference was not significant. The teams did not appear to differ in the size of the bonus they received nor in the average numbers of words and messages they used.

Based on the results of these analyses, I conclude that though teams 6 and 16 were composed of friends, friendship did not appear to affect their performance.

Question #16: How well did you get to know each of your teammates by communicating with them in this experiment?

The 2 x 2 factorial Anova of the ratings for this question yielded no significant results. The variables of switching and appointed helper apparently had no effect on how well the subjects got to know each other.

Question #17: What tips, advice, or suggestions would you give about using this experiment?

The large number of suggestions given in response to this question fall into two broad categories: procedural and technological suggestions. Procedural suggestions pertain to the way subjects used the communication equipment, to the group process, and to the way team members relate to one another. Examples include, "State the facts -- ideas briefly and with supporting evidence, listen to rebuttals, take notes, then respond to each one" (subject A, team 17), "Use first names" (subject B, team 2), and "Try to forget entirely that you are on camera and might be monitored; don't move around out of camera range" (subject D, team 2). Sixteen subjects suggested that the group should have some sort of leader. It is interesting to note that ten of the suggestions came from subjects in the switched

condition. This is still further evidence to support the hypothesis that many of the B subjects in this condition did not seem to behave as leaders very visibly.

Technological suggestions deal with the communication equipment, the way it is constructed, and what can be done with it. Examples include, "Make addition of teletype, printout or other (swivel mount and close focus) so that visual aids, charts, etc., could be included" (subject D, team 14), "Give a monitor for the speaker (for his own edification and to keep his eyes near the camera)" (subject A, team 6), and "Have an 'off' switch so that when one person is through speaking, he isn't on the others' screens" (subject C, team 4). Eleven subjects in the switched condition made suggestions about the use of switching. All suggested that the telecommunication system should be open and not have a switching system as this one did.

SUMMARY

One variable of great interest -- the switching variable -- produced several rather interesting effects. Teams in the switched condition took about eight minutes longer than teams in the nonswitched condition to solve problems. Even more important were differences in verbal output between the two conditions. Subjects in the switched condition packaged their messages differently than did subjects in the nonswitched condition. Subjects in both conditions spoke about the same number of words, but subjects in the switched condition said one-quarter as many messages and used four times as many words per message as did subjects in the nonswitched condition. This result is clearly related to the freedom to interrupt and to gain the floor to speak which is inherent in the nonswitched condition but not in the switched condition.

Teams in the nonswitched condition had a slight performance superiority based upon the rank correlation data obtained from the two rank ordering problems. However, this difference disappeared when all four problems were examined together.

Subjects in both conditions liked their communication systems equally well, though both systems received mixed reviews.

Another variable of interest -- the role variable -- produced fewer significant results than anticipated. The most important effect relates to the helper's role in acting as a moderator or organizer of group discussions. This function was most apparent in the number of words used for solution of the Fire Safety problem in the switched condition. The Fire Safety problem was an open-ended and ambiguous kind of problem which required the helper to structure the group problem solving effort. To do so, the helper spoke much more often than his teammates. Such an organizing function may have its drawbacks, however. Based upon the rank correlations for the rank ordering problems, the helper was not able to argue as forcefully for his point of view

and may have lost some influence on the final group solution.

It appears that giving power and responsibility to someone chosen randomly is not enough to make him become a group leader. The lack of switcher and/or helpers who came to be perceived as group leaders bears this out. Perhaps appropriate personality characteristics must also be present in an individual before power can be used effectively. Personality might therefore be a variable which warrants attention in future experiments.

Subjects appeared to learn and to adapt to the experimental situation over the course of the four sessions. Over the four days, the number of words and messages decreased and the number of words per message increased, though the last was true only for the switched condition.

In almost every analysis the variable that accounted for most of the variance was problems. Many significant problem effects were due to the difference between the Fire Safety problem and the other three problems. These differences reflect the undefined and difficult task that subjects faced in solving the Fire Safety problem.

The results of this experiment enable me to recommend a solution to the multi-site teleconferencing problem discussed in the Introduction. Although there are differences between the two teleconferencing systems tested in this experiment, what is more important is that the differences are so few and so small. Subjects solved problems only slightly less well in the switched system than in the open system. Moreover, their attitudes to the two systems were about equal. Given the higher cost of a completely open audio and video system, and the slight performance differences between them, I conclude that a switched system such as was used here would be a suitable choice for multi-site teleconferencing.

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APPENDIX A

Instructions for Fire Safety Problem

FIRE SAFETY AND PREVENTION

Here's the situation:

The number of fire deaths occurring in Baltimore City each year is quite large and is increasing. As a result, the Mayor has recently begun a vigorous campaign to increase public awareness about fires and about their prevention.

The typical Hopkins student, like everyone else, is exposed to th danger of fire where he lives, whether it is in dormitc es, apartments, or row homes. Also, like everyone else, he is not as aware as he should be about the ways fires can be prevented and how to survive should one break out.

Here's the problem:

With this in mind, imagine that each of you has been chosen as a student member of a committee which has as its goal the increased awareness of fire safety and prevention among Hopkins students. Specifically, your task is to prepare a list of the 15 best actions that should be taken by students to prevent fires where they live. The list can include tips about hazardous situations that should be avoided and how to survive should a fire break out.

The items on the list should apply to students living either on or off campus.

As an incentive, you will be paid a bonus of up to several dollars depending on the number of items on your list that match ones found on an authoritative list compiled by the National Fire Prevention Association.

I'll make all decisions about what constitutes a match and all my decisions are final.

Please don't begin your discussions until I tell you to begin. After I tell you to start, your discussions will continue until you reach a solution and one of you tells me that you're finished.

APPENDIX B

Criteria for Fire Safety Problem

CRITERIA FOR FIRE SAFETY PROBLEM

1. Install and use properly fuel-burning space heaters and appliances.
2. Don't use flammable liquids, e.g., gasoline, to start or freshen a fire, or for cleaning.
3. Fireplace should be equipped with a metal fire screen.
4. Allow proper ventilation when using portable gas and oil heaters.
5. Keep space heaters away from traffic routes.
6. Clothing should be kept away from space heaters.
7. Provide proper clearance between curtains, bedding, and furniture and sources of heat.
8. No smoking in bed.
9. Check for cigarette butts smouldering in sofas or upholstered furniture.
10. Dispose of smoking materials properly (not in trash cans) and provide large ashtrays.
11. Keep matches and lighters away from children.
12. Run electrical cords in the open -- not under rugs or through door openings.
13. Check electrical cords routinely for wear.
14. Use proper size fuses in fuse box.
15. Replace blown fuses with proper size; find the cause.
16. Don't store cookies, candy, etc. near stove where children can get burned.

17. Keep basement, closets, garage clean of combustibles (papers, cartons, oil-soaked rags).

18. Store gasoline, paint, and other flammable liquids properly -- in closed containers made for that purpose (not glass or plastic bottles).

19. Store flammable liquids away from heat, sparks, and children.

20. Dispose of old paint-laden brushes.

21. Be sure furnace, stove, and smokepipes are away from combustible walls and ceilings.

22. Furnaces, stoves, and smokepipes should be in good repair.

23. Have heating equipment checked yearly by a serviceman.

24. Have chimney checked and cleaned regularly.

25. Roof should be constructed of fire retardant material.

26. Have proper number of electrical outlets per room.

27. Have special circuits installed for heavy-duty appliances such as space heaters and air conditioners.

28. Have qualified electrician install or extend wiring.

29. Appliances should carry the seal of a nationally known safety testing laboratory, e.g., U.L.

30. Determine two means of escape from each bedroom.

31. Draw up a floor plan showing all possible escape routes for each member of the family.

32. Have some type of warning system -- smoke detector, whistles.

33. Practice escape procedures.

34. Never leave children unsupervised.

35. Teach children safety techniques, e.g., no climbing on or reaching across stove; how fires happen; recognition of hazards.

36. Don't fill a hot lawnmower. Let it cool first.

37. Allow air space around the television to prevent overheating.

38. Wear tight-fitting clothes when you cook.

39. Smother a pan fire with a lid. Never use water -- it will explode.

40. Sleep with bedroom door shut.

41. Have fire department telephone number readily available.

42. Know how to test a door to see if it's safe to open.

43. Keep escape routes free from obstruction.

44. Set a meeting place outdoors for a heat count of family members.

APPENDIX C

Problem Materials for Energy Conservation Problem:

1. Instructions
2. Answer Sheet

ENERGY CONSERVATION IN THE HOME

Here's the situation:

Imagine that you recently bought an old 2-story brick row home with 1350 square feet of floor space. Your row home is typical of the end-of-row row homes found in Baltimore City and is structurally sound, but its 13 windows and 2 doors are in dire need of maintenance. The row home was built long before the "energy crisis," so there is no insulation from the basement to the unfinished attic. You have to find a way to cut down on your home heating and cooling costs -- you've just spent over $80.00 for electricity to air condition the place in July and can expect to spend over $500.00 for fuel oil this winter. Your exasperation is rising as quickly as your fuel bills.

Eight home improvements that the experts suggest are listed on the next page.

Here's the problem:

Sure, all of those home improvements will save fuel and money. But they'll also cost money to install, even when you do the work yourself. Furthermore, the improvements vary widely in their cost-effectiveness. Since you have a limited budget, you want to start with those improvements that are the best investments -- the ones that will give you the greatest dollar savings per dollar invested in materials and services.

Your group's task is to select the 4 best home improvements from the 8 suggested by the experts. By "best," I mean the ones that will give the greatest ratio of net savings to installation cost.

I have been able to find authoritative cost/effectiveness data for the 8 home improvements. I know how much each costs to implement and how much each will save. Based on that information, I will pay a bonus of up to several dollars depending on the correctness of

your group's solution.

Please don't begin your discussions until I tell you to begin. After I tell you to start, your discussions will continue until you reach a solution and one of you tells me that you're finished.

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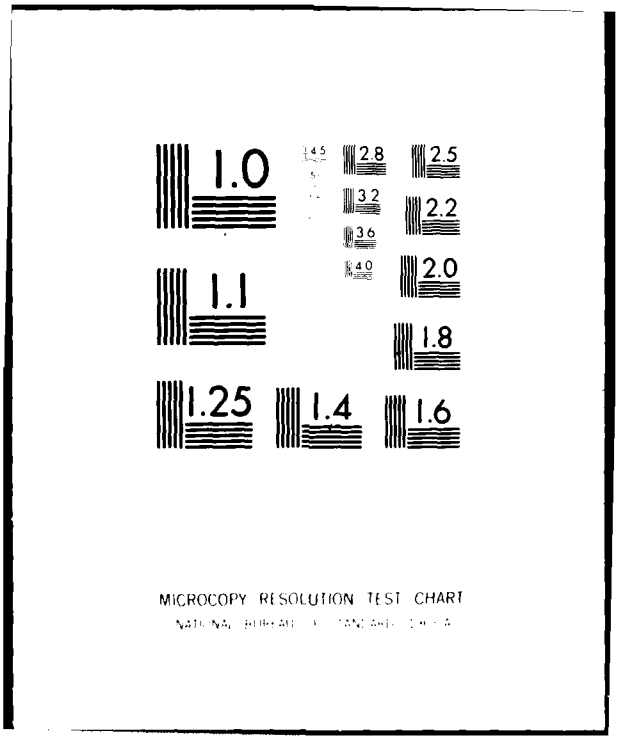
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ENERGY CONSERVATION IN THE HOME

Here are the 8 home improvements suggested by the experts:

1. Insulate the basement walls
2. Have the central air conditioning checked annually by a professional
3. Have the oil furnace checked annually by a professional
4. Caulk and putty around the windows and door frames.
5. Weatherstrip the windows and doors
6. Put on glass storm windows
7. Insulate the frame walls
8. Insulate the attic

The 4 best home improvements are:

_____

_____

_____

_____

APPENDIX D

Problem Materials for National Issues Problem:

1. Instructions
2. Answer Sheet for Part I
3. Answer Sheet for Part II

NATIONAL ISSUES

Here's the situation:

Many unresolved issues face this country. Several of these are listed on the next page. While each is primarily of an economic, environmental, political, or social nature, all are of national concern and their speedy resolution would benefit us all.

Massive government attention and funding has been extremely effective in solving difficult problems -- as witness, the placing of a man on the moon. If this same kind of unified effort were to be focused on each of the issues in turn, the probability of their resolution in the near future would be enhanced.

Here's the problem:

Imagine that you've been selected by your fellow students to represent them on an ad hoc committee. The purpose of the committee is to make recommendations to the President concerning the reordering of the economic, political, environmental, and social issues facing this country.

First, I'd like each of you to individually rank order the 10 items in the order you think the average undergraduate would rank them if he could "reorder our national priorities" in the order of their importance. A sheet with the heading "NATIONAL ISSUES PART I" has been provided for that purpose. I'll give you several minutes, then I'll collect your rankings. Your rankings won't be used in the next part of this problem nor will they be shown to your team mates.

Your next task is to rank the 10 items jointly as a group. As you did on the first part, I'd like you to rank the items as you think the average undergraduate would if he could "reorder our national priorities." A sheet with the heading "NATIONAL ISSUES PART II" has been provided for that purpose.

One more thing.... Some time ago, a questionnaire was administered to a large number of undergraduates. Based on the results of the survey, I know how the average undergraduate would rank the 10 items. As an incentive, I'll pay a bonus of up to several dollars depending on how close your joint ranking is to the average ranking obtained in the survey.

Please don't begin your discussions until I tell you to begin. After I tell you to start, your discussions will continue until you reach a solution and one of you tells me that you're finished.

NATIONAL ISSUES PART I

A. Provision of equal opportunity in education

B. Achievement of a stable peace in the Middle East

C. Control of inflation

D. Finding a truly effective treatment for drug addiction

E. Development of alternative energy resources (e.g., nuclear, solar)

F. Allocation of highway funds to mass transit

G. Restoration of confidence in the political system

H. Reform of the judicial and penal systems

I. Achievement of zero population growth

J. Increased consumer protection through legislation

Ranking for Part I: fill in letter:

Highest Priority	1.	_____
	2.	_____
	3.	_____
	4.	_____
	5.	_____
	6.	_____
	7.	_____
	8.	_____
	9.	_____
Lowest Priority	10.	_____

NATIONAL ISSUES PART II

A. Provision of equal opportunity in education

B. Achievement of a stable peace in the Middle East

C. Control of inflation

D. Finding a truly effective treatment for drug addiction

E. Development of alternative energy resources (e.g., nuclear, solar).

F. Allocation of highway funds to mass transit

G. Restoration of confidence in the political system

H. Reform of the judicial and penal systems

I. Achievement of zero population growth

J. Increased consumer protection through legislation

Ranking for Part II: fill in letter:

Highest Priority	1.	_____
	2.	_____
	3.	_____
	4.	_____
	5.	_____
	6.	_____
	7.	_____
	8.	_____
	9.	_____
Lowest Priority	10.	_____

APPENDIX E

Problem Materials for University Budget Problem:

1. Instructions
2. Answer Sheet for Part I
3. Answer Sheet for Part II

UNIVERSITY BUDGET RECOMMENDATIONS

Here's the situation:

As students, we are all too familiar with the rising costs of getting an education. Every year, as operating expenses increase, the University budget does likewise resulting in increased tuition, lab fees, and room and board. Naturally, the burden is felt heaviest by the students.

Cost increases seem to be an inevitable part of academic life. However, steps can be taken to reduce their size. Ten such steps are listed on the next page.

Here's the problem:

Imagine that you've been selected by your fellow stndents to represent them on an ad hoc committee. The purpose of the committee is to make recommendations to the University Administration concerning financial matters.

First, I'd like each of you to individually rank order the 10 items in the order you think the average undergraduate would recommend them to the University. A sheet with the heading "UNIVERSITY BUDGET RECOMMENDATIONS PART I" has been provided for that purpose. I'll give you several minutes, then I'll collect your rankings. Your rankings won't be used in the next part of this problem nor will they be shown to your team mates.

Your next task is to rank the 10 items jointly as a group. As you did on the first part, I'd like you to rank the items as you think the average undergraduate would. A sheet with the heading "UNIVERSITY BUDGET RECOMMENDATIONS PART II" has been provided for that purpose.

One more thing.... Some time ago, a questionnaire was administered to a large number of undergraduates.

Based on the results of the survey, I know how the average undergraduate would rank the 10 items. As an incentive, I'll pay you a bonus of up to several dollars depending on how close your joint ranking is to the average ranking obtained in the survey.

Please don't begin your discussions until I tell you to begin. After I tell you to start, your discussions will continue until you reach a solution and one of you tells me that you're finished.

UNIVERSITY BUDGET RECOMMENDATION PART I

A. Delay construction of new buildings and renovation of old ones

B. Cut the plant operating expenses

C. Cut the M.S.E. Library operating budget

D. Freeze pay hikes for faculty

E. Freeze the hiring of new instructor personnel

F. Cut the size of the administrative staff and services

G. Raise the student tuition and fees

H. Decrease financial aid to students

I. Institute a tri-semester at the University

J. Eliminate the Intersession

Ranking for Part I: fill in letter:

Recommend first 1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
Recommend last 10. _____

UNIVERSITY BUDGET RECOMMENDATION PART II

A. Delay construction of new buildings and renovation of old ones

B. Cut the plant operating expenses

C. Cut the M.S.E. Library operating budget

D. Freeze pay hikes for faculty

E. Freeze the hiring of new instructor personnel

F. Cut the size of the administrative staff and services

G. Raise the student tuition and fees

H. Decrease financial aid to students

I. Institute a tri-semester at the University

J. Eliminate the Intersession

Ranking for Part II: fill in letter:

Recommend first 1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
Recommend last 10. _____

APPENDIX F

Instructions to Subjects

INSTRUCTIONS TO SUBJECTS

INTRODUCTION

The purpose of this experiment is to find out how people solve problems when they communicate in different ways.

Even though you are located in separate rooms, you will be able to see and hear one another through the closed-circuit television and microphone-speaker system. From now on, for the purposes of confidentiality, each of you will be identified by the letter corresponding to the room you're in. A, B, C, and D. The television monitors are labeled with the letters corresponding to the people in the other rooms.

APPOINTED (SW & NONSW)

As you might suspect, running an experiment such as this one involves a lot of coordination, paper shuffling, and just plain hassle. To help me, and to make this go a little smoother for all of us, I have chosen one of you to do a couple of the things I normally would do. The subject I have chosen is subject B. The duties which B will perform over the next four sessions are to read the problem instructions prior to the start of the session, to act as a liaison between the team and me by relaying to me any questions any of you might have during the problem sessions and then relaying back my responses, to tell me when a solution has been reached and what that solution is, and finally, after the problem solving session is over, to arrange a time for the next session. B, there is a card on your desk which lists these duties.

(PAUSE) ARE THERE ANY QUESTIONS?

SWITCHING
(APP & NONAPP)

By now, you've probably noticed the grey box on the table in front of you. It's part of a signalling and switching system specially constructed for this experiment which is modeled after several systems currently in use in business, education, and government. This system has a master control box in B's room, and three smaller signal boxes located in the other three rooms. The system is set up so that only one person can talk and be seen at a time. It works this way:

Let's assume that A wants to talk. Because the channel is not open for him to talk, A must first push the red button on his signal box which says "I WANT TO TALK" when lit. This lights A's red button and also lights a button on B's box which says "A WANTS TO TALK." To open the channel to A, B then pushes the green button light on A's box which says "YOU MAY NOW TALK," letting A know that he can talk and be seen by the others until B gives control to someone else.

CLEAR TO EVERYONE?

A, press your red button.

B, is A's red button lit?

B, push A's green button.

Can you all see A?

ETC. FOR B, C, AND D.

I should point out that B doesn't have to wait for a red signal light before opening the communication channel to someone. He can open or close anyone's channel at any time.

In return for your participation, each of you will be paid $2.00 for each session in which you participate, for a total of $8.00 for the four sessions. In addition to your base pay, each of you will also be paid a bonus ranging up to several dollars for each problem solution depending on the correctness of your team's solution. To get the bonuses, however, your team has to complete all four sessions. Since the bonus will be the same regardless of how long you take to solve the problem, and since you'll get $2.00 for each session, it's to your advantage to work as carefully yet as quickly as possible.

You will be paid in full by check within about a week after the fourth session, but I prefer to keep the solutions confidential until after the experiment is over. At that time, you can get copies of the solutions in my office in 245 Ames Hall.

ARE THERE ANY QUESTIONS SO FAR?

If you are agreeable to these procedures, please turn over, read, and sign the top sheet of paper. Also address the envelope and complete the next sheet which has as its heading "Pagerey Dissertation Experiment" so that I can send you your payment. PLEASE PRINT LEGIBLY!

(COLLECT, AND THEN HAND OUT PROBLEM INFORMATION)

NON APP & SW, & NON APP & NON SW — O.K., please turn over the sheets of paper I just handed out to you. They give information about the first problem. I'll read the instructions.

APP & SW, & APP & NONSW — O.K., turn over the sheet of paper which gives details of the first problem and read that page aloud to your team mates while I'm setting up the experiment. Please don't begin your discussions until I tell you to begin.

(ASK B IF THERE ARE ANY QUESTIONS.)

APPENDIX G

Questionnaire Questions

INSTRUCTIONS

On the following pages, I ask questions about the communication medium you used in your discussions and about the group of people you worked with. Although some of the questions could be answered with a simple one or two word answer such as "Yes" or "No," I would greatly appreciate it if you would explain your answers fully.

Several questions ask you to rate your attitudes or opinions on a scale of 1 to 6. On those, show your rating by putting a check mark on one of the six lines which corresponds to your answer.

This questionnaire is completely voluntary and anonymous. Answer only the questions you want to answer and don't sign your name.

THANK YOU

1. Rank order your team's members, including yourself, on each of the following by putting one of the subject identification letters (A, B, C, D) on each of the numbered lines. For example, if you felt that A contributed most to the discussion your group had followed by C, then D, and finally by B, you would mark part a. of this question as indicated below.

EXAMPLE: a. Overall contribution to the discussion:

Contributed most A (1) C (2) D (3) B (4) Contributed least

a. Overall contribution to the discussion:

Contributed most ____ (1) ____ (2) ____ (3) ____ (4) Contributed least

b. Number of ideas introduced during the discussion:

Most ideas ____ (1) ____ (2) ____ (3) ____ (4) Fewest ideas

c. Quality of ideas introduced:

Best ideas ____ (1) ____ (2) ____ (3) ____ (4) Worst ideas

d. Amount of participation:

Participated most ____ (1) ____ (2) ____ (3) ____ (4) Participated least

e. Concern for getting the job done:

Most concerned ____ (1) ____ (2) ____ (3) ____ (4) Least concerned

f. Concern for the social climate in the group:

Most concerned	____ 1	____ 2	____ 3	____ 4	Least concerned

2. Often, a "leader" or "chairman" emerges in group discussions like the ones you've participated in. Sometimes, more than one leader emerges. For the discussions your group held, did a leader seem to emerge? Consider the entire group including yourself. (Use a check to indicate your response(s).

_____ No leader emerged.

_____ One leader emerged. He was: ___ A ___ B ___ C ___ D
(Now go to Question 3)

_____ More than one leader emerged. They were: ___ A ___ B ___ C ___ D
(Now go to Question 3)

3. Why do you feel the individual(s) you chose in the previous question was (were) leader(s)?

4. a. How much do you think your discussions were affected by having someone control who talked and when they talked? (Put a check over only one number.)

They weren't affected at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	They were greatly affected

If your discussions were affected, how were they affected?

4. b. How much do you think your discussions would be affected by having someone control who talked and when they talked? (Put a check over only one number.)

They wouldn't be affected at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	They would be greatly affected

If your discussions would be affected, how would they be affected?

NOTE: Question 4.a. was given to subjects in the switched condition and 4.b. to subjects in the nonswitched condition.

5. How much easier might your tasks have been if you had met face to face in the same room? (Put a check over only one number.)

About the same	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	Very much easier

If your tasks would have been easier, how would they nave been easier?

6. How much easier might your tasks have been if you had met over the telephone? (Put a check over only one number.)

About the same	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	Very much easier

If your tasks would have been easier, how would they have been easier?

7. How conscious were you that you were being observed and that your conversations were being recorded? (Put a check over only one number.)

I wasn't conscious at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	I was very conscious

8. How well did you like communicating this way? (Put a check over only one number.)

I didn't like it at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	I liked it very much

9. What did you like about communicating this way? (Be sure to mention more than one item if necessary.)

10. What did you dislike about communicating this way? (Be sure to mention more than one item if necessary.)

11. How much did your team seem to improve from session to session in its ability to use this communication equipment?

It didn't improve at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	It improved a great deal

How did this improvement show itself?

12. How much did your team seem to improve from session to session in its ability to solve the problems?

It didn't improve at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	It improved a great deal

How did this improvement show itself?

13. Could your team have done better if it had had a different number of people in it?

About the same	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	A great deal better

If your team could have done better, how many people should have been in it?

14. Was there anything, at any time, that kept your team from performing at its best? What was it?

15. How well did you know each of your team mates before this experiment began? (Leave the rating scale for yourself blank.)

I didn't know A at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	I knew A very well
I didn't know B at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	I knew B very well

I didn't know C at all	1	2	3	4	5	6	I knew C very well
I didn't know D at all	1	2	3	4	5	6	I knew D very well

16. How much better did you get to know each of your team mates by communicating with them in this experiment?

I didn't get to know A any better	1	2	3	4	5	6	I got to know A much better
I didn't get to know B any better	1	2	3	4	5	6	I got to know B much better
I didn't get to know C any better	1	2	3	4	5	6	I got to know C much better
I didn't get to know D any better	1	2	3	4	5	6	I got to know D much better

17. Imagine the following.... You are going to talk to some friends about your experiences in this experiment. Your friends have a business which has branches in several other cities. In the past, they have had to travel a great deal to conduct meetings and conferences with staff at the other branches. With the rising cost of travel (and also the tremendous amount of time it takes to travel) they decided to install a telecommunications system similar to the one you just used. This new system will allow them to conduct meetings with their branches without even having to leave their offices. Your principal concern is that they might use their communication equipment effectively and to their greatest advantage. What tips, advice, or suggestions would you give them

about using this equipment? Use the back of this sheet if you need more room to write your suggestions.

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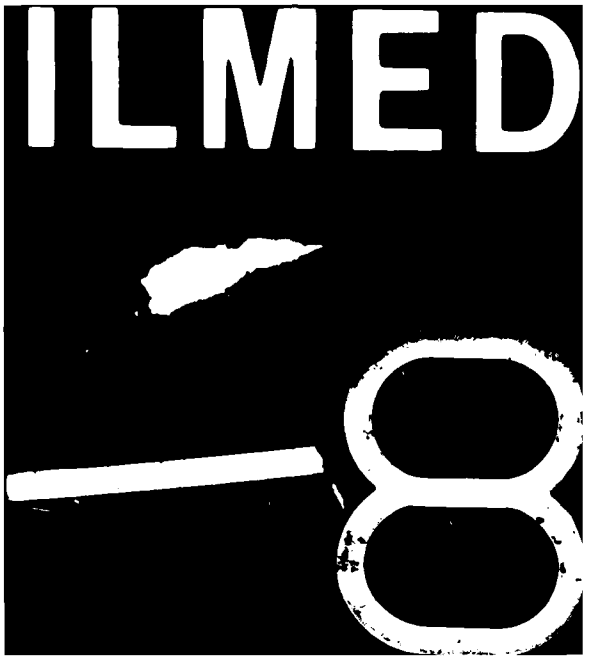
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